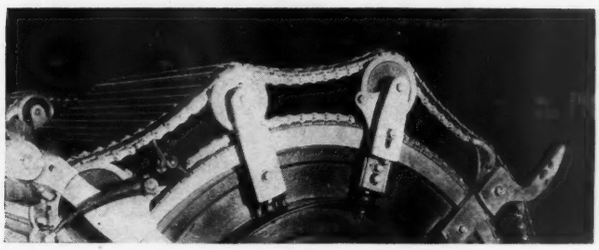
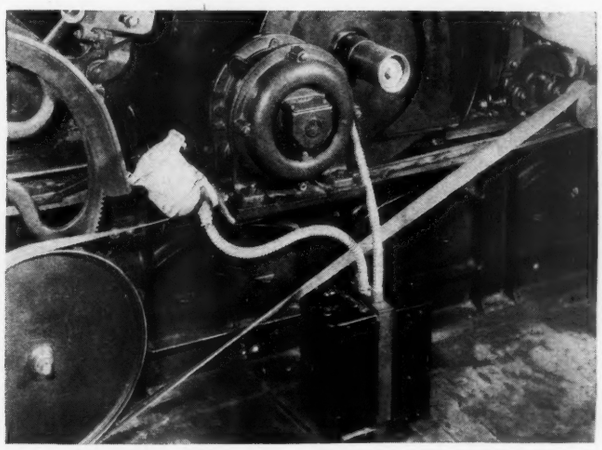
FACTORY MANAGEMENT and MAINTENANCE

JUNE, 1933



Are You Ready for a Shorter Day?



Shorter hours are "in the cards." Whether they come all at once as part of a national program for economic recovery, or more gradually through concerted action within industries, more people must work fewer hours to make more money. Are you ready to change over to a six-hour day? Mr. Rositzke's discussion of how a certain textile mill will meet the situation suggests basic problems you will bump up against some day

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ALL COMPANIES in a seasonal business, operating at better than 60 per cent activity, whose labor represents a large portion of the total manufacturing dollar, will be faced with a series of difficult problems with the introduction of any measure approximating a 30-hour week. Such problems will be compounded unless some form of minimum wage provision is made that will uniformly affect all companies within a given industry. The introduction of a 30-hour week without any minimum wage standard will give the low-wage manufacturers a further advantage over the producer paying a fair wage.

Some executives have risen to combat the forced restriction of hours; a second class has been undecided and phlegmatic; a third group has actively sponsored measures that would increase employment. Executives in the third class realize, however, the inherent difficulties and appreciate the pitfalls that might beset the road through poor administration of a highly desirable objective.

An outstanding textile concern in the East, realizing the potential problems, has been carefully preparing its course of action to meet the various conditions that may arise. Its plans have been made as flexible as possible, in order to be able to meet either national or trade regulation of employment. They must vary according to whether the minimum wage provisions are incorporated on a national basis, through internal activity of their own branch of the industry, or not provided for at all.

The factors deserving major consideration were classified as shown in the table on the two following pages, and will now be discussed. Others will doubtless come to your mind.

Factories and Factory Locations. Should there be a federal minimum wage law non-enforcible on production distributed within the state in which it is manufactured, several serious difficulties present themselves. This

particular company will have to decentralize its activities to several other states where most of its goods are distributed. This possibility has been analyzed, potential plant locations have been reviewed, the prospective sizes of the units gaged, supervisory requirements anticipated, and general organization plans necessary for such a drastic change contemplated.

In such an event, central production planning and control must be provided. The present factory personnel has been carefully analyzed with an eye to prospective supervisors of the smaller units. Incentives to intensify instructional effort in training green help have been outlined. The machinery and equipment have been classified in the larger units so that a definite schedule of moving can be quickly completed and supplementary equipment purchased if it is found necessary.

Pay day at the Kellogg Company, Battle Creek, Mich.,

Personnel. Many factors entered into the consideration of personnel contingencies that will have to be anticipated. If there is any limitation to the number of six-hour shifts that a company may operate, equipment and floor space will be the major problems in regard to the general supervisory staff. On the other hand, if the number of six-hour shifts is unlimited, the company must provide a supervisory staff that will take care of the difference in number required for the old basis and the prospective six-hour shifts. Working foremen have been carefully considered as to their eligibility for work of an exclusively supervisory nature.

The clerical problem has been considered from several angles. Should the clerical force work only six hours in accordance with the shift idea? Or should floor space be provided for additional people? A compromise measure was thought most suitable. All clerical help working on factory production records and transactions will work on a shift basis, whereas those engaged in routine work will be considered in the light of regular six-hour daily operatives.

Turning to direct workers, an analysis of personnel records disclosed a possible source of experienced help of approximately 20 per cent. If the manufacturing units are to operate as they are now, in the present location, it means that there will be an increased requirement of 50 per cent in help. This means that at least 30 per cent of the increased labor requirements will have to be trained unless productivity of present operators is increased.

The community in which the factories are located is highly industrialized. The shortening of hours will increase the labor demand considerably, thereby stiffening labor rates. At the same time it will be the desire of all forward-looking plant executives to offer their help the opportunity to earn the same wage or a better one.

The management of the company under consideration decided to investigate every possibility for increasing the present productivity of operators. Potential increases in sales prices were also taken into consideration in arriving at ways to maintain wage rates.

All methods changes desirable have been carefully tabulated as to their relative importance and potential effect upon earnings possibilities. Detailed time studies, and in repetitive operations motion-study analyses, have been completed as a basis for ascertaining potential earning possibilities through corrective training. The formulation of incentive rates, based on time study, clearly determines rate adjustments necessary for different earning levels. Such rates and adjustments in machine assignments are all balanced in readiness for a change.

It is thought that the reduction to a six-hour day will eliminate the need for cafeteria service. This will release sufficient floor space to accommodate necessary stand-by and other machinery requirements.

Machinery and Equipment. Should companies be allowed single six-hour shifts only, the machinery and

Problems of

Factories and Locations

1. Present locations
2. Necessary locations if federal minimum wage restrictions are enacted
3. Desirability of maintaining present locations in face of increased labor demand, equipment requirements, or need for decentralization

Personnel

1. Supervisory Staff
   (a) Increased number required
   (b) Staff arrangement if continuous or 12-hour operation must be resorted to
   (c) Clearer definitions of salaried and hourly rated supervisors
2. Direct Workers
   (a) Analysis of potential supply of trained labor
   (b) Estimate of possible training requirements, etc.
   (c) Wage policies — present rate, decreasing total earned income, increased rates to offset loss in hours, or retention of old earning levels through methods improvements, modernized wage plans, etc.
   (d) Space reduction possible through elimination of

which has been on a six-hour day since December, 1930

equipment purchases in this particular case would be tremendous. Operations were therefore classified into three major groups:

1. Those operated on a six-hour basis.
2. Those normally operated twelve to fifteen hours.
3. Those operated continuously.

In all operations that are to be, or can only be, operated on a six-hour day, substantial machinery and equipment purchases will be required. On all operations that are to be extended to a 12-hour operation of two six-hour shifts, increase in the amount of stand-by equipment must be provided. Operations normally conducted on a 24-hour basis will not be affected as to machinery and equipment required. Floor plans were developed for housing this additional equipment if the factories are to operate in their present locations.

Repair and Maintenance. Schedules of additional stand-by equipment necessary were formulated in order not to impose an unusual peak load on the repair crew and so that normal repairs could be accomplished by the day repair shift.

Intensification of machine inspection programs is anticipated as a means of reducing the necessity for night-shift repairs. Proper lighting and paint requirements in departments that would operate on a 12-hour basis were considered, necessary adjustments noted, and schedules planned.

Clerical and Control Work. The change to a six-hour day will raise many problems in this particular phase of management. Decentralization into a greater number of units will require the development of a centralized planning unit, and the enlargement of cost and payroll divisions. Such possibilities have not been entertained very seriously, however, by the management.

The problem, should the plants continue as they now are, incorporates a need for more office space, more efficient layouts, a staggering of starting and stopping hours so as not to jeopardize customer service. Payroll work will be increased considerably for the same force unless longer pay periods are considered. (The latter suggestion was brought up as a way to meet this problem.) Intensified research for the most recent and improved office appliances has resulted in the incorporation of automatic check writers and signers, and more modern tabulating equipment.

Of course, any such forecasting of requirements by a company is highly problematical. However, the company reviewed in this article thought it highly desirable to anticipate as many angles as possible. It has been operating relatively close to capacity for several months. Its merchandising efforts have been successful throughout the depression. This has been accomplished with the retention of wage levels higher than those existing in competitive units, through rigid inspection methods, maintenance of quality, continuous reinvestment in the modernization of its plant facilities, and close cost control of the most modern type.

The relatively higher rate of activity has impressed the executives of this company with the many-sided nature of the problem. The task of meeting changes in working hours will be tremendous, but it is their thought that unit cost increase is inevitable. Higher sales prices are anticipated. Aggregate increased unit labor costs, accompanied by stiffened prices, will mean greater purchasing power, larger sales at fair profits, resumption of dividends, return of purchasing power.

All manufacturers will be affected to a greater or lesser degree. Some will find labor their biggest problem, and, in the major sense, their only problem because of excess capacity. In such cases the intensity of the challenge to their ultimate livelihood will depend upon their future efficiency, their relative position in the industry, the sound nature of their competition and price structures, and the character of impending legislation.

the 6-Hour Day

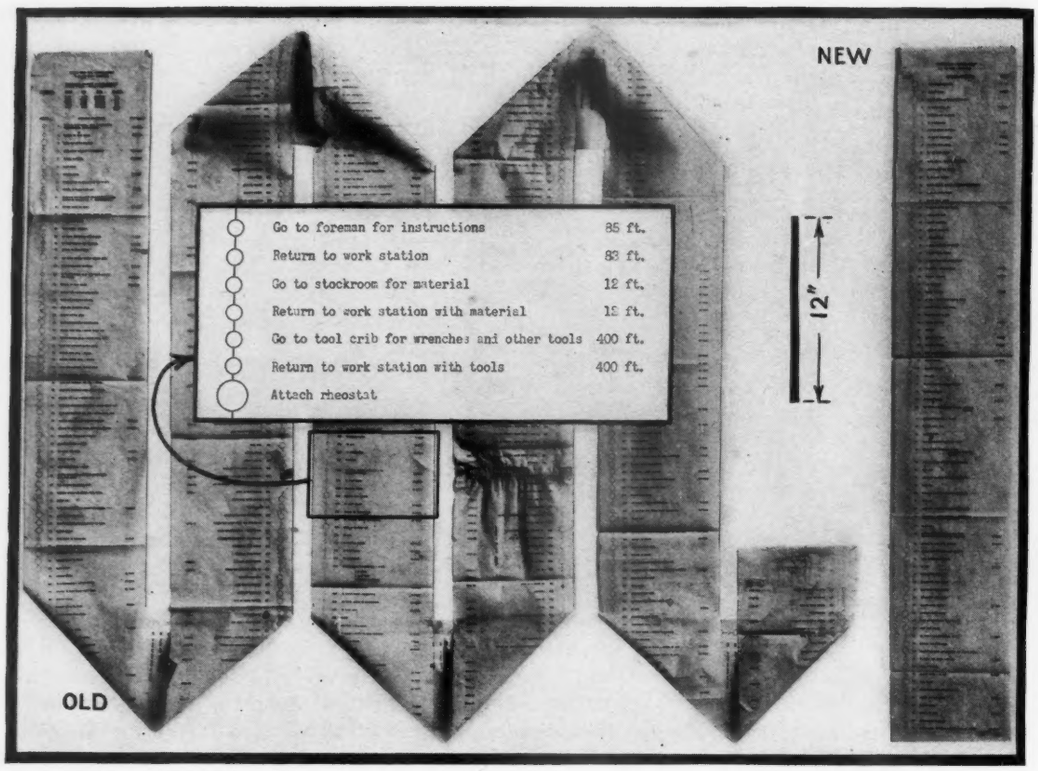
cafeteria service; provision for increase in locker facilities
(e) Establishment of tentative shift schedules

Machinery and Equipment

1. Additional Facilities Required
   (a) If no more than single six-hour shifts are permitted
   (b) If number of shifts is unrestricted, improved lighting and fire prevention equipment
2. Repair and Maintenance
   (a) Stand-by equipment for operations brought to 24-hour basis
   (b) More preventive machine inspection to avoid late shift difficulties
   (c) Paint as an aid to illumination
   (d) Closer scheduling of repair work

Clerical and Control Work

1. Decentralization requires a change in production scheduling
2. Factory payroll, timekeeping, and record work will be increased considerably
3. Determination of office force necessary, present and potential, as well as space requirements


NEW
Go to foreman for instructions 85 ft.
Return to work station 83 ft.
Go to stockroom for material 12 ft.
Return to work station with material 12 ft.
Go to tool crib for wrenches and other tools 400 ft.
Return to work station with tools 400 ft.
Attach rheostat
12"
OLD

OLD METHOD
4,284 feet
18.7 hours
3 skilled men

NEW METHOD
663 feet
12.1 hours
1 skilled man
1 helper

Figure 1. "Before" and "after" process charts—part of several that indicated the need for a portable tool crib to eliminate the miles of walking shown on the charts

The Process Chart—indicator of profitable changes

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Process charts are part of management's measuring tools. Without measuring tools, management's guesses will be as costly as the guesses of workmen

THE MANUFACTURE of the long line of General Electric products in so many plants has brought into use various methods of time study and planning procedure as well as different wage-payment systems. Wide experience has been gained. On some products, one method of time study and planning gives the desired results, but for other products a different method is needed. Although all methods are based on the same underlying principles, we have found that no one procedure could be applied to all products.

We have found that all time-study methods are first of all *measuring tools of management* and of definite use when applied in a common sense way. They are useless unless translated into action. We shall point out what we mean by "common sense" use of these important measuring tools of management by the following analogy to the measuring tools of workmen.

First consider the workman. He uses a caliper and

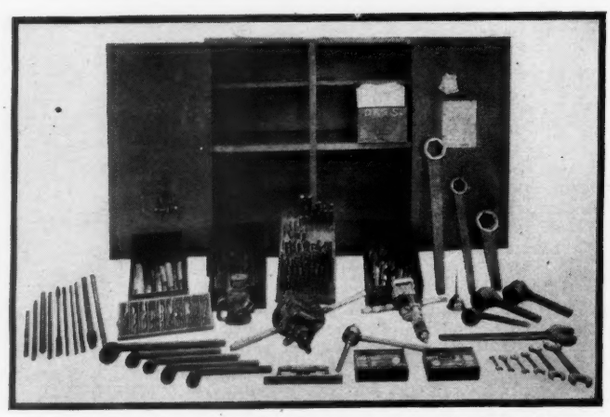

Figure 2. The portable tool crib can be dropped right on the job by the crane, and contains the drawings and tools that formerly meant many needless trips by high-priced men as well as helpers

Workman's Tools	*Management's Tools*
Caliper and scale	Process chart and time study with stop watch
Micrometer	Camera and microchronometer Analysis of film by Gilbreth method

scale for rough dimensions only. He does not expect to read to thousandths of an inch unless he uses the proper measuring tool—the micrometer. Even in these days of strict economy we would not think of depriving him of his necessary measuring tools. Management knows it cannot afford to pay for his "guess" measurements.

Now consider the management. We use the process chart and time study, which are management's *rough* measuring tools, only where *rough* measurements will give the desired results. We do not expect "micrometer" results unless we use the camera and microchronometer.

If management does not use any measuring tool, will its "guess" measurements be less expensive than the "guess" measurements of the workman? Must we not apply the same common sense to the use of management's measuring tools as the workman does to the use of his?

Our first measuring tool is the process chart. It is simply a detailed recording, in proper sequence, of any method or process. This method or process may be handling or moving materials, movements of operators in the factory, or of workers in the office. It may be a combination of any or all of them.

Process charts are easy to make. To show how simple they really are we have set a few lines of "Old Mother Hubbard" to the tune of a process chart:

Old Mother Hubbard went to the cupboard	40 ft.
Arrives at the cupboard	2 min.
Searches for food and finds none	15 min.
Borrows from next-door neighbor	2 min.

A process chart of "Old Father Hubbard," who works in the factory, might look like this:

Went to the tool crib	40 ft.
Arrives at the tool crib	2 min.
Searches for tools and finds none	15 min.
Borrows from next job	2 min.

When a process chart is laid before those in charge of supervision they can visualize what is actually taking place and immediately see what can be done to improve the method, often without expensive changes. Sometimes what is *actually* taking place does not agree with what they *think* is taking place. Merely making them agree results in improvement with no expense.

The addition of the rough time taken together with distance traveled is beneficial, and sometimes such a process chart can be used in place of a time study.

We have found that since it is so easy to visualize what is actually taking place the process chart has been an excellent means of encouraging prompt action.

Process charts do not take the place of time studies, but they simplify the work very decidedly. When time studies are necessary, they should *follow,* but *never precede* the making of process charts. The use of the process chart as an instruction sheet for the foreman and workman insures the desired method will be followed.

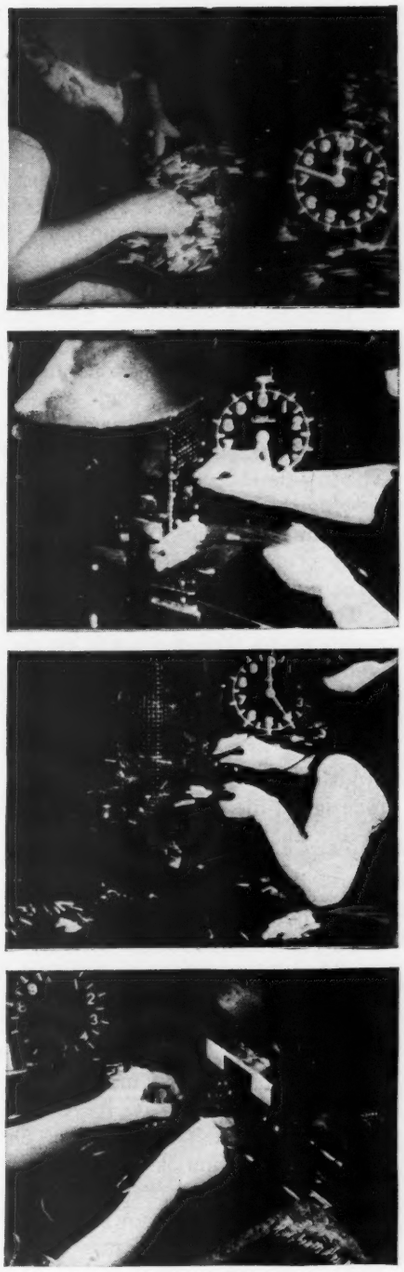

Figure 3. As shown in the first illustration, one girl placed a copper tube over the stripped end of the wire. Done in the usual manner—one hand holding all the time. Following this, there were three press operators engaged in first flattening the end of the tube into a lug, and then punching the hole and trimming the corners. In these operations, the girls held the leads in one hand and fed the press with the other, as shown. When completed, they were placed in a container on the other side of the operator

▶ All this was shown when the process charts were made, there being no need for a micromotion study to indicate the opportunities for improvement. The Gilbreth clock is shown in the photographs, however, as the operation was later filmed to illustrate the improvement made

▶ As a result, a machine was set up, feeding the stock directly into place, so that one operator can now use both hands, in symmetrical and opposite directions, and work with less fatigue, as shown in the last illustration

Everyone agrees that it is folly to take time studies before the job is ready, whether to set standards or to accumulate data for charts and tables. Such time studies result only in inaccurate standards and data. When methods are improved and standardized by the analysis of process charts, time studies can then be taken and accurate standards set.

We have been making process charts here at West Lynn for some time. Much of the work is assembly work, and, as in the case of large turbines, does not lend itself readily to detailed time studies. Process charts, however, have in many instances shown where substantial economies could be made. One such study is illustrated in Figure 1, which shows both the "before" and "after" charts.

Analysis of the process chart of this job showed that no great improvement could be made in the time spent in

actually performing the operation. We show it as a good example of the saving in time that can result when tools and materials are brought to the operators. Walking is expensive when paid for at the rate of a skilled operator. The photograph in Figure 2 shows how a tool crib was made that eliminated miles of expensive walking because it could be brought to the operator.

Process charts also are well suited to the study of the operation of machine equipment. A typical illustration of the approach to simplification of work and the effect on the design of equipment is shown in the job of making up terminal leads (see the four photographs grouped in Figure 3). This job was being done by four operators, one assembling and three operating punch presses.

A process chart was made of this first method and the analysis immediately showed the possibility of eliminating two punch press operations by redesigning the die. The tool designer was therefore brought in; he, too, after viewing the problem from his analysis of the chart, saw the same possibility. With his knowledge of motion-study principles he designed a die which combined the three punch press operations into one.

The assembly operation was eliminated by using a magazine to feed the stock to the remaining operator, who made the assembly while the press was operating.

This is a good example of what happens to the design of a die or tool when the designer is well grounded in the principles of motion study. There is no difficulty in arousing his enthusiasm when he sees what part the redesigned die contributes to the improvement as shown by the analysis of a process chart. Much more can be done by machine-tool builders to incorporate sound motion-study principles into their design. It is gratifying to see how enthusiastically some of them are doing so when process-chart information is available. In the past the "do it" has received most of their attention. Process charts are showing that the "make ready" and "clean up" now require equal attention.

After standards have been set, we are all prone to expect them to be self-maintaining, only to find at some later date that costs have increased because *no standards ever have been self-maintaining.* One function of a time-study organization is to set standards; an equally important one is to see that they are maintained. Reference to the process chart shows at once "why not." Here is another use for the process chart. Since it shows the reasons why the cost has increased, we find that both supervisor and workman use them, not to *settle* disputes but to *prevent* them.

Two new measuring tools that are helping to maintain standards are the time meter and time analyzer. These meters give a continuous check measurement and show how well we are using our equipment. Often they can save the time-study man from the necessity of retiming the job. (See "How Many Hours a Day Do Your Machines Work?" by J. Decker, *Factory and Industrial Management,* November, 1932.)

The "micrometer" measuring tools of management are the camera and the microchronometer—in other words, moving pictures of the job with a special time clock in the picture to show the time taken. The film is later projected and analyzed by the Gilbreth method. This measuring tool is the only one that gives the "micrometer" results necessary for repetitive jobs of very short cycle.

As we pointed out in our analogy to the measuring tools of workmen, do not use this "micrometer" measuring tool of management where the rough measurements —the process chart—would have given the desired results. However, we cannot emphasize too strongly the value of film analysis as a means of training supervision to become motion-minded. This use has often been overlooked. A few hours' instruction in the principles of motion economy, so well worked out by the Gilbreths, is needed. It should be followed by showing a film of "old" and "new" methods which will visualize these principles and give supervisors enough to start them off. Operators can then be trained by supervision to use motion economy, and thus the difficulties of training new operators are lessened.

Too often we have associated these measuring tools of management with factory problems only. They have broad and equally "common sense" application to office and general expense labor and methods.

Time meters are time savers

We have given the measuring tools of management in the order in which we use them. The results obtained from their use will be in direct proportion to the intelligence and common sense with which supervision applies them.

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Are Factory Foremen Radicals?

TWENTY-SIX foremen, asked for expression of likes and dislikes, put themselves on record like this:

	Like	*Indifferent*	*Dislike*
Socialists	0	12	14
Bolshevists	0	3	23
People who have made fortunes in business	22	4	0

Twenty-one college juniors gave this expression of likes and dislikes:

	Like	*Indifferent*	*Dislike*
Socialists	5	12	4
Bolshevists	2	8	11
People who have made fortunes in business	9	12	0

I collected these data incidentally in making an extended research into the possibility of devising tests to measure potential executive ability. Strong's "Vocational Interest Blank" was the medium used. It was filled out at the end of a ten weeks' period of weekly educational conferences, during which time a mutual feeling of confidence was built up between the foremen and me as conference leader. It was made clear to the foremen that their cooperation in filling out the blanks was entirely voluntary, and assurance was given that individual answers would be held strictly confidential. A. F. DODGE

Assistant Professor Industrial Education
University of Illinois

Beginning a series of six short articles on

Maintenance Cost Control

I—Duties of Maintenance Division

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MAINTENANCE and the control of maintenance costs are important factors in the operation of any manufacturing concern, and of vital importance in highly mechanized industries where a breakdown would disrupt production schedules.

A maintenance policy has of necessity a three-range point of view: (1) the repair procedure to take care of running repairs and breakdowns; (2) the preventive procedure to maintain the entire plant equipment in good operating condition over a period of years; and (3) the need to have the total maintenance cost in keeping with the factory income.

In each factory of each industry with its own type and condition of equipment, a proper balance must be struck among the three procedures. Too little prevention means high repair costs and production delays; on the other hand, preventive maintenance in excess of the worth of the equipment or production expediency also means high maintenance costs. At all times the company must safeguard its cash position. The success or failure of a specific policy in a factory in balancing the three factors can be judged only from surveys made from time to time of the entire equipment, and the effect of the policy on the liquidity of the company's assets.

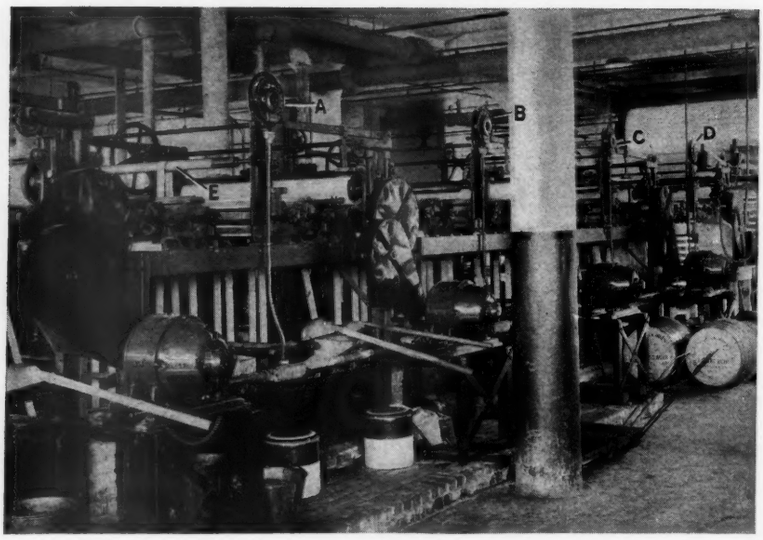
The maintenance problem exists in every plant, and maintenance work is being done continuously. Scientific management has developed a separate division to handle all maintenance work rather than continue the practice of having each productive department do its own.

[1] "Industrial Organization and Management," by W. B. Cornell, pages 390-403. Ronald Press.

The specific duties of the maintenance division depend upon the maintenance policy of the company and the condition of the plant. In the average modern plant, the following duties[1] are included in the work of the maintenance division:

1. Upkeep of buildings, grounds, and fences. Proper maintenance for factory buildings and grounds keeps down costs of repair and replacement, lessens depreciation, encourages plant morale, and eliminates many causes of accidents.
2. Fire and plant protection.
3. Make emergency repairs.
4. Make systematic inspection of all machinery and equipment in order to detect anything which might cause breakdown of machinery or failure of equipment.
5. Keep tickler records of schedule of inspection.
6. Make repairs or replacements, as shown necessary by the inspection records.
7. Make reports to the head of the operating division and to the head of the production division as to needed repairs and replacements and the date upon which work on them will be started.
8. Make estimates on all maintenance work costing more than a stipulated amount, above which no maintenance work can be undertaken until estimates are made and approved by the proper authority.
9. Suggest changes in design of machinery and equipment to eliminate excess wear and to reduce the number of repairs and adjustments.
10. Disseminate information in regard to the care and operation of machinery and equipment.
11. Keep on hand and readily accessible a sufficient stock of materials, repair parts, and tools to take care of emergency repairs and routine maintenance work.
12. Timekeeping, costing, and records.

This outline of duties reflects an energetic policy of preventive maintenance. If no thought or time is given to systematic inspection and to repairs according to the inspection reports, the duties of a maintenance division would be simply "make emergency repairs."



Four motors work in tandem as material passes from section to section of the washer. Variable-voltage control is used to vary the speed of the group. Material passing the rider rolls, *E*, operates dancer roll rheostats *A, B, C, D,* which synchronize the speeds of the motors

Get the Speed You Need With Variable-Voltage Control

To operate machines at highest efficiency, production must vary driving speeds, and control them accurately. Maintenance must provide suitable means. Here's one way

Paul W. Arnola

Development Engineer
The Reliance Electric & Engineering Company, Cleveland

POWER delivered by electric motors controlled by a variable-voltage system is one of the most versatile tools available to industry. The source of power may be a direct- or alternating-current motor, or a gas, oil, or steam engine—in fact, any source of power that can be used to drive a direct-current generator.

Variable-voltage systems are used to control elevators, and to operate the motors of huge mechanisms that pick up, rotate, and dump freight cars loaded with coal or ore. Paper is carried through great machines at high speeds, in the course of its manufacture, and the most modern of these machines are equipped with control systems dependent on the simple principle of variable voltage. This same system is also put to more humble tasks, such as controlling laboratory testing equipment, the motors driving cloth-finishing machinery, and so on through a long list.

Figure 1 (see page 220) illustrates the simplest arrangement of variable-voltage control. In the great majority of cases the prime mover is an a.c. motor, usually a constant-speed type, although a variable-speed may be used. It is mechanically connected to a d.c. generator, which in turn is electrically connected to the d.c. motor or motors that drive the load. The shunt fields of the motor and generator must be excited at a constant voltage, supplied by the plant system or by a separate exciter.

The speed of the driving motor may be altered by varying the voltage impressed on its armature by the d.c. generator. The generator voltage may be changed by varying the speed of the prime mover, or by varying the generator shunt field strength by turning its rheostat.

Practically, the speed of the d.c. driving motor will vary directly with the voltage impressed on its armature. If the voltage ranges from 230 to 23 volts, the motor speed will vary, say, from 1,200 r.p.m. down to 120 r.p.m. Over that range the motor will deliver the same torque in pounds-feet; so the power available is in direct proportion to the speed. If the motor develops 10 hp. at 1,200 r.p.m., it will develop 1 hp. at 120 r.p.m. For many applications in which the load is largely frictional, the lower available power is ample.

The question of whether the speed can be carried below 120 r.p.m. comes up. From Figure 2 it will be seen that the working range depends on the nature of the load and the speed regulation required, particularly

at low speeds. When the voltage is varied on the d.c. motor, its current input remains constant and its horsepower output varies directly with the speed. This is shown by curves *1* and *2*. When the voltage is set and a speed between zero and 1,200 r.p.m. is obtained, speed variation is caused by changes in load, which cause changes in current input. The magnitude of the speed change or regulation is dependent on the amount of variation in the current input.

With a 10-hp. load at 1,200 r.p.m., a ½-hp. change in load would cause a current variation of about 2 amp. in load current (4 amp. per horsepower has been assumed at 230 volts), which would cause a small speed change, since 2 amp. is only a small percentage of the full-load current of 40 amp. At 120 r.p.m. this ½-hp. change in load has a much different effect. At this point 1 hp. is produced by 40 amp. instead of 4 (see curve *1*). So a ½-hp. load change would change the current 20 amp., or 50 per cent, and with a large consequent change in speed.

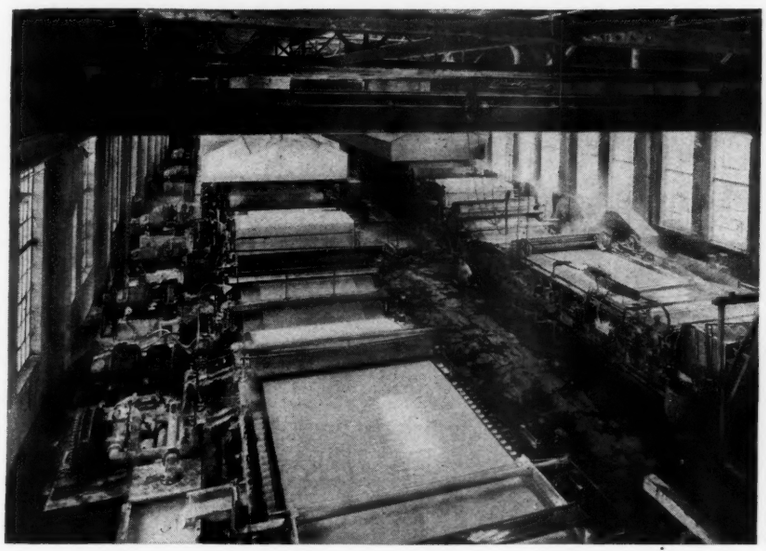
As the speed drops below 120 r.p.m. these conditions are even more marked. Although this feature must be fully understood and considered, it is seldom troublesome, because the speeds are low and usually even wide variations do not cause trouble. Often variations never occur since the loads are fairly steady. Nevertheless, the designer must make certain that the load imposed on the motor is not greater than that shown by curve *2*, Figure 2, because if the 20 amp. referred to is the result of a ½-hp. overload at the low speed, it means that both the motor and generator are carrying a 50 per cent overload in current.

The speed of the d.c. motor may be raised above 1,200 r.p.m., if safe to do so, by inserting resistance in the field circuit by means of the rheostat. In the case of the 10-hp., 1,200-r.p.m. motor used, as an example, the speed might be raised as high as 1,800 r.p.m. with safety. The output from 1,200 to 1,800 r.p.m. would be 10 hp. at all speeds. So there is a workable range from 120 to 1,800 r.p.m.; even below 120 r.p.m., if load and regulation conditions permit.

Wide speed range is one of the prime advantages of variable-voltage control, but not the only one. Smooth, flexible acceleration from zero to top speed, and ease of synchronizing two or more motors over a wide range are also important features.

A thorough understanding of the foregoing basic facts must be had if one is to understand variable-voltage drives and make full use of them. To illustrate the uses of variable-voltage control, a few typical applications will be discussed.

A laboratory wanted to test automobile transmissions and differentials under speeds from practically zero to a maximum corresponding to the engine speed at 75 m.p.h. After investigation a 3,600-r.p.m., 230-volt d.c. motor was selected for the drive. Variable voltage was supplied by a 230-volt generator driven by a squirrel-cage motor. The control circuit was substantially the same as in Figure 1, although a magnetic contactor, opened and closed by "start" and "stop" pushbuttons, was introduced into the circuit.



The paper machine in the foreground is driven by nine d.c. variable-voltage motors. Variable-voltage control makes possible the speed variation required for different weights of paper and is the foundation for the control required to synchronize the speeds of the nine motors

In operation the generator rheostat is turned to the low-voltage position and the "start" button is pressed. The rheostat is advanced until the motor starts; then the speed is increased to 3,600 r.p.m. as rapidly or slowly as desired. The effect of slowing a car down can also be duplicated by turning the generator rheostat toward zero speed, which produces regenerative braking. Control of test speeds from zero to 75 m.p.h. is obtained simply by turning a rheostat.

One of the valuable applications of variable-voltage control involves synchronization of the speeds of several continuous-process machines or sections of the same machine. The principal speed variation of the drive motors is obtained by variable voltage and the synchronization by other devices. Examples are found in paper, textile, and steel mills, and plants manufacturing cellulose products, such as cellophane and rayon.

In general, the product travels from one machine or section to the next. Due to changes in the product, it is usually impossible to tie the sections or machines together mechanically, because the material might pile up or break between sections. Also, in some processes it is desirable to vary the speed of one machine relative to the next for different products or even in the processing of a single product. Variable-voltage control provides variable speed and a sound foundation on which to build the synchronization features.

Figure 3 shows the schematic diagram of the electrical and mechanical layout of such a scheme. Three motors are shown, but as many as required may be used. Major speed changes of the motors are obtained by turning the generator rheostat.

A simple case is illustrated in Figure 4, to show what

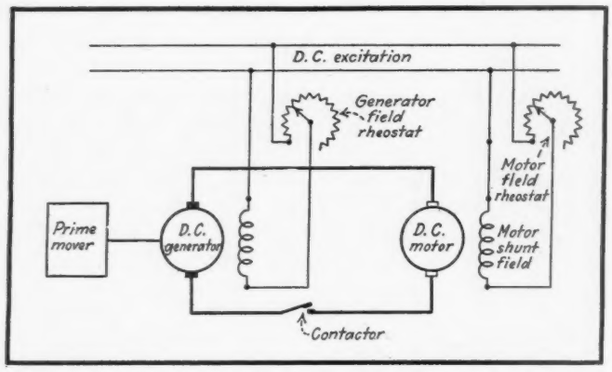


Figure 1. Basic electrical connections for a system of variable-voltage control. By turning the generator rheostat, the speed of the d.c. motor may be varied over about a 10:1 range

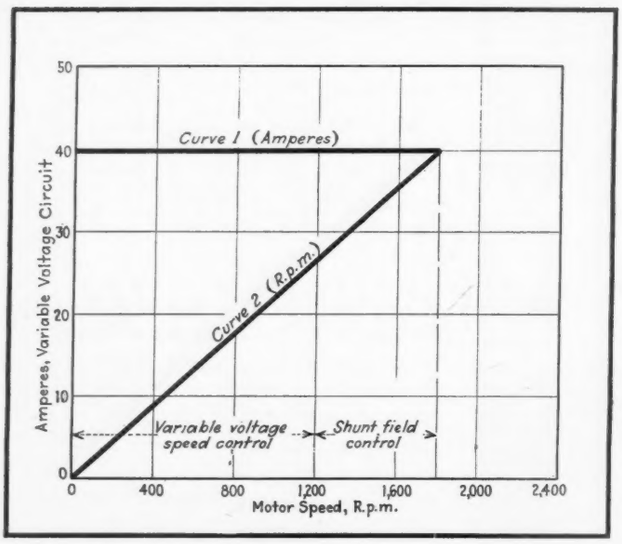


Figure 2. Relation between ampere input to motor and its speed, with variable-voltage control. The motor is assumed to be of 10-hp. rating

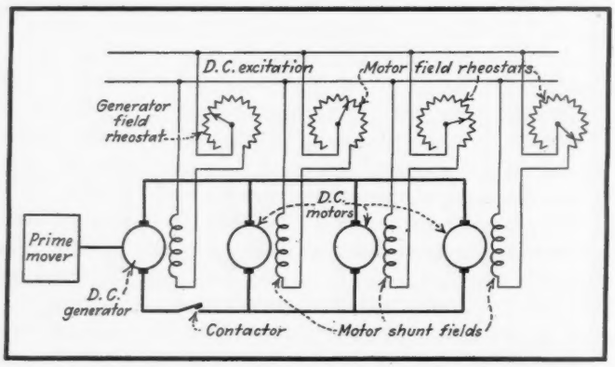


Figure 3. With a variable-voltage system of control for synchronized drives, as many motors as needed may be used

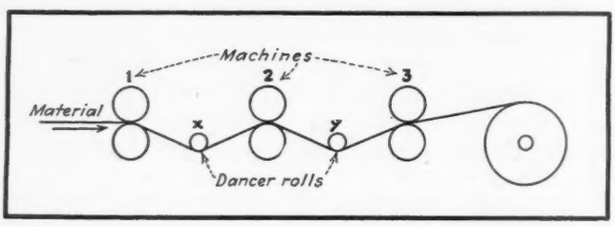


Figure 4. Rolls *1*, *2*, and *3* represent machines working in tandem and producing a material by a continuous process. "Dancer rolls," *X* and *Y*, are connected to rheostats and serve to synchronize the speeds of the driving motors, so that the material will not pile up or tear between the machines

the drive motors must do. A material, say cloth, is passed through three machines driven by separate motors. Obviously, if the cloth shrinks in process, it will tear between machines; if it stretches, it will pile up. Furthermore, the motors cannot be expected to run at exactly the same speed, because of uneven heating, loading, and so on.

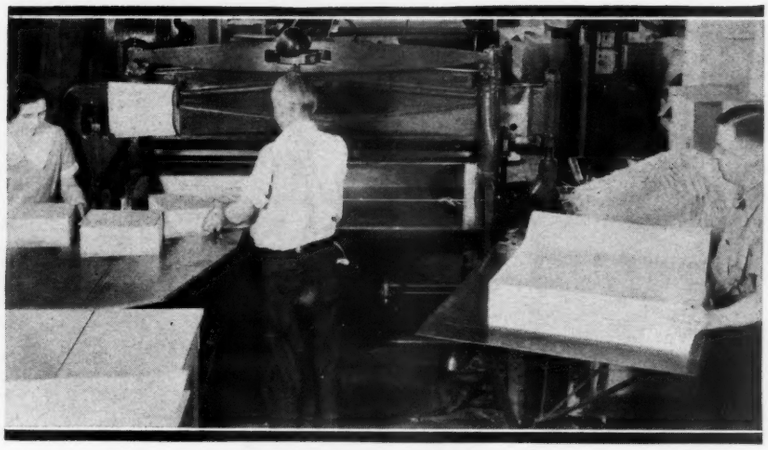
Synchronization is easily accomplished by putting on the loops of material between machines, rider rolls mechanically connected to "dancer roll" rheostats. If the cloth between machines *2* and *3* (Figure 4) shrinks, the rider roll will rise, causing the rheostat to weaken the shunt field of the motor driving machine *2* and thus speed it up until the roll returns to its normal position. If slack tends to pile up, the roll will drop, causing the motor of machine *2* to slow down. The action, of course, travels back to the motor of machine *1* in the same way.

Oftentimes the material handled may not be touched by a rider roll, and then the problem is more difficult—but it can be solved.

It was said previously that the variable-voltage generator may be driven at a variable speed. Such a system is frequently used in "gas-electric" drives on buses or trucks. Some unique and simple industrial machine drives of that sort have been devised. One example is found where a material, say paper, which is delivered at a variable speed from a machine, must be wound into a firm, even roll. It is necessary to keep the peripheral speed of the winder drums the same as that at which the paper is being delivered. The variable-voltage generator is mechanically connected to the variable-speed shaft of the paper machine; hence its speed and voltage vary in direct proportion, and the voltage which it impresses on the motors driving the rolls varies their speed in the same ratio, so that the desired roll speed is automatically obtained.

It is desirable in some cases to use a rider roll on the paper between the machine and the winder to protect against tear or pile-up. Sometimes shaft winders instead of drum winders are used, and similar drives can be worked out to accommodate the requirements.

This description of variable voltage applications might be continued. It might include main roll drives in steel mills, paper calender drives, electric shovel equipment, controls for small motors used in various branches of the textile industries, and so on. Perhaps even the main drives on electrically propelled ocean-going ships might be included. However, this description of typical applications of variable-voltage equipment to industrial plant machinery shows how the basic ideas set forth have actually been put to work. One generalization we can make—if variable speed, synchronization of machines, or sections of machines working in tandem is needed, it will pay to investigate variable-voltage-controlled electrical drives.



"One of the trimming machines in the parchment division was overcrowded. We thought we should have to buy a new one, until one of the men suggested a swinging table that let one man load while the other kept the machine going all the time"

"We use a club to keep people thinking" *says*

Jacob Kindleberger

President, Kalamazoo Vegetable Parchment Company
Kalamazoo, Mich.

Not a "big stick," however. Just an informal "Concentrating Club" that brings in ideas. What of it, if only one in 500 is any good? The main thing is to start people thinking, and keep them thinking, about their jobs

SYSTEM and efficiency are not neglected by the Kalamazoo Vegetable Parchment Company. Its plant has just emerged from a long program of expansion and modernization, and its product research, cost and budget control, and other phases of management give evidence that it has availed itself of the best modern practice. The real enthusiasms of the company's president, Jacob Kindleberger, become apparent, however, when he is expounding his ideas of dealing with people.

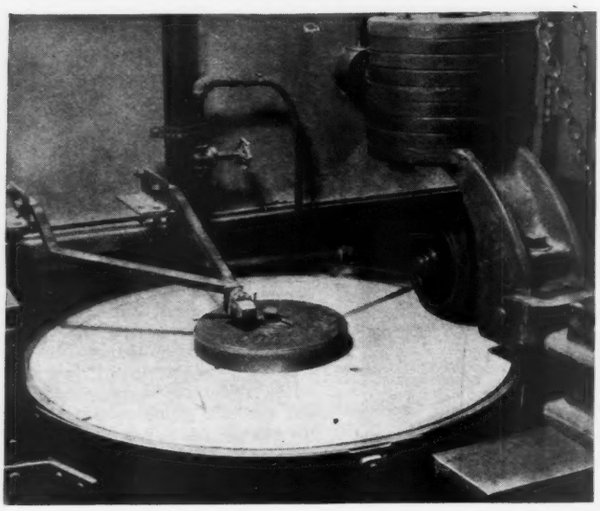
"For a long time," says Mr. Kindleberger, "we have had a 'Concentrating Club.' In the old days, when I was on the road selling paper, I found I did much of my best thinking after hours. Used to think up slogans on the train and write them down, and later I would find a customer who would use them. We started the same idea in the Concentrating Club. Any employee who put in one hour a week outside of working hours, concentrating on how he or the company could do a better job, was eligible.

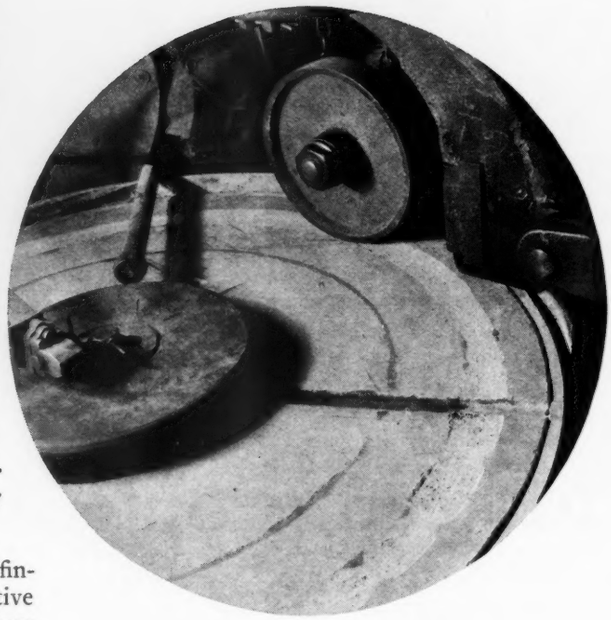
"It doesn't matter so much whether the ideas are good or bad. Maybe only one in 500 will be really important. The main thing is, it starts people to thinking about their work. At first our employees were shy, afraid they'd look foolish. When they found we took them seriously, we got lots of suggestions; many of them worth while. We made one 10 per cent wage cut last spring. That seemed a good time to revive interest in the Concentrating Club. So we had a meeting of all the head men. Explained why the cut was necessary. It might even be necessary to make more reductions; other companies had. Prices were down, they all knew that, and we did not know but they might go further. It might be possible to avoid more wage reductions, if we could cut costs in other ways.

"Could it be done? Would it be a good thing to ask the Concentrating Club to help? Some thought it would; some weren't sure. We wanted them to generate their own enthusiasm. The fire burns brighter when you lay two logs together. We considered various ways of reducing costs, and everybody was agreed that wage-cutting was not the way to do it.

"Well, finally everybody was pretty well sold on the idea that we could get costs down by reducing rejects and quality rebates, by watching idle time and stopping waste. We put it up to these head men to sell the idea to their departments, using the Concentrating Club as a way to get people to thinking.

"Members of the club brought in many good ideas. One of the trimming machines in the parchment division was overcrowded. We thought we should have to buy a new one, until one of the men suggested a swinging table that let one man load while the other kept the machine going all the time. Another man suggested pressed-steel cores or plugs for the ends of the rolls of paper we produce, instead of wood cores which shrink and fall out. Another devised a compressed-air fixture to start winding a roll of paper; it turned a loss on that operation into a profit. But the main thing was to get everyone thinking."





To Prove the Product

IF THE practice of making accelerated tests of the finished product did not originate with the automotive industry, at least it owes much of its present acceptance to the successful operation of the now familiar proving ground. Recent converts to this practice include the B. F. Goodrich Company of Akron, Ohio, whose engineers have made accelerated laboratory tests to determine the effects of rubber-tired and metal wheels upon reinforced concrete floors. The tests illustrate how the proving ground idea may be adapted to other service problems, and indicate how wear and tear on factory floors may be minimized through the selection of equipment and materials with the modern concept of preventive maintenance firmly in mind.

Tests were made on two exactly similar disks of reinforced concrete, using a standard floor mix. Disks were 36 in. in diam., 2½ in. thick; were built with one ¼-in. expansion joint and one ⅛-in. standard section joint. Used in the test were one metal and one rubber-tired wheel, each 9 in. in diam. with a 1¼-in. face. Load on each wheel was 383 lb. Speed was uniformly maintained at 83 r.p.m. Results: The metal wheel broke the concrete at both joints and wore a path in the concrete after 44 min. of operation, or 3,632 revolutions. The rubber-tired wheel, after 46 hr. and 231,650 revolutions, left no trace of wear or tear on the surface of the disk

Heard and Seen

J. Madden

MR. EDITOR, I'm moved to pour into your supposed-to-be sympathetic ear some of the trials of a traveler—meaning myself.

I started out fresh enough in the cool of the morning, but as the day wore on the heat increased. What with walking all over a couple of plants and doing considerable driving, my feet were more than tired when I called on Mr. Alpha.

It was a small reception room; in fact I filled it, with one foot reaching over into the general office. And there I stood for some ten minutes after I had given my card to the young lady; stood until she thought to ask me into the office where I could have a chair. It was a "grand and glorious" when I got me down.

My next visit was to the plant of Mr. Beta. I'm told it's the last word. "No Admittance to Plant—Office on Second Floor." Blithely I mounted the stairs, and there it was, sure enough, at the top of the flight. At any rate there was the waiting room. Size about 6x12 feet; cut off from the really nice, big main office by 7-foot partitions with pebbled glass; a grill work for the information girl; two hard chairs; rubber mat.

I had to wait—not too long—but still enough to germinate impatience. I sensed that they had me down for the first fall. I could feel the old inferiority creeping over me. Nothing to look at, except glass walls; nothing to read; hard and straight sitting; no ash tray; no drinking water. Had I been there to buy I'd have been tempted to drive a hard bargain. As it was, my idea generator was only vaporizing, instead of boiling, at interview time.

More cases could I tell about. But I'm mollified now that I've written something. I'll conclude by saying that no one who hasn't experienced the trials of a traveler should be permitted to design a reception office. There are some perfect ones. The muse has visited me several times as I sat in some comfortable chair, relaxing mind and weary muscle—and more than once with an idea that was for the good of industry. I know it'll happen again.

Management ought to recognize the potentialities of comfortable, inspirational reception rooms.

Prorating Purchased Power Costs

It's a job you have to do if power cost is an appreciable fraction of the value of the finished product. And not hard if you understand basic customer, energy, and demand charges, and don't overlook penalties and credits for special conditions

Carl W. Evans

Industrial Sales Engineer
San Antonio Public Service Company

ALL ADEQUATE systems of cost accounting require the correct allocation of power costs to the various divisions of a factory. Accurate allocation is specially desirable where power is used for many dissimilar purposes, and where the cost represents an appreciable fraction of the value of the completed products. With purchased power, the problem is not complicated. In general, the method of prorating power cost will depend upon the rate structure under which the factory is billed for electric service, and upon the nature of the service required by the different departments.

Practically all service companies have adopted a type of structure known as the three-part rate, even though it may be made almost unrecognizable through the various methods used to embody such a structure in, apparently, simple steps. This structure includes a fixed charge usually termed a "customer's charge," a demand charge, and an energy charge. The function of the customer's charge is to furnish that portion of expense which varies, practically, with the number of customers, such as meter reading, billing expense, high-bill investigations, bad debts, etc. The demand charge, as the name implies, is a charge proportional to the cost of furnishing the maximum requirements of the customer. It is based upon various intervals. In many cases the demand of a customer is taken as the maximum consumption in any 15-minute period during the month. In other instances the demand period may be five minutes or one hour, depending entirely upon the practice of the particular utility. In many instances the billing demand is taken as the average of some definite number of peaks occurring during the month. In one company, each month is divided into three equal parts, and the average of the peak demand in each is used. The third factor in the cost of power is an energy cost directly proportional to the kilowatt-hours of energy consumed.

In addition to these basic charges, most power contracts include various penalties and credits for special conditions. A few of them are power-factor penalty or credit; fuel clause penalty or credit; primary service credit (a discount for accepting service at transmission voltage, in which case the customer furnishes his own transformers); and off-peak credits, whereby the customer obtains a lower rate during prescribed periods.

While at first sight it would appear that the proration of such complicated rate structures might be most difficult, it is not actually so. Each structure for a given plant must be analyzed and reduced to a formula—usually a simple one. Consider the following example:

Rate
First 5,400 kw.-hr. @ 5c.
Next 60 hours' use of maximum demand @ 4c.
All in excess of above @ 0.7c.

Fuel Credit and Penalty
Whenever the cost of boiler fuel to the company during the calendar month next wholly preceding the billing date is greater or less than sixteen cents ($0.16) per million (1,000,000) B.t.u., the bill will be increased or decreased accordingly at the rate of one-tenth mill ($0.0001) per kw.-hr. received by the customer for each five-mill increase or decrease in such cost of fuel up to a maximum adjustment of one mill per kw.-hr.

Power Factor Credit and Penalty
Credit, three-tenths of one per cent for each whole one per cent increase in average monthly power factor above 80 per cent lagging up to unity; penalty, three-tenths of one per cent for each whole one per cent decrease in average monthly power factor below 80 per cent lagging.

In such a rate structure, which is quite general, the uninitiated will find no such simple factors as customer charge, demand charge, and energy charge readily apparent. Such a rate, however, may be easily reduced to a simple formula. In most cases the rate will only be justifiable where a customer uses a sufficient number of kilowatt-hours to satisfy all three steps, which will make it possible to utilize one formula for all monthly statements.

As an example of the method used to derive the formula, assume that a plant uses "*e*" kw.-hr. per month and that "*e*" is large enough to furnish kilowatt-hours in all three steps of the rate; let "*d*" equal the monthly maximum demand in kilowatts; let the power factor approximate 70 per cent; and assume the fuel clause credit to be 0.5 mill per kw.-hr. for that particular month. Then "*C*," the total cost of power for the month, would be:

$$C = (5{,}400 \times 0.05) + (60d \times 0.04) + 0.007 \\ (e - 5{,}400 - 60d)$$

Neglecting for the moment the power factor and fuel clause credits or penalty, and simplifying the above

Rate structures, however complicated at first sight, may be reduced to simple forms. Then the energy and demand charges for each plant section are determined by means of sub-meters and demand meters. To these figures add a share of the customer charge to obtain the total cost of power allocated to the department

TABLE 1

Rate Structures Reduced to Formulas

e = total kilowatt-hours used
d = maximum demand in kilowatts
C = total cost

Rate No. 1		*Formula*
First	100 kw.-hr. @ $0.08 ea.	$C = \$0.08e$ where $e =$ 0 to 100
Next	900 kw.-hr. @ 0.07 ea.	$C = \$1.00 + 0.07e$ where $e =$ 101 to 1,000
Next	2,000 kw.-hr. @ 0.06 ea.	$C = \$11.00 + 0.06e$ where $e =$ 1,001 to 3,000
Next	7,000 kw.-hr. @ 0.05 ea.	$C = \$41.00 + 0.05e$ where $e =$ 3,001 to 10,000
Next	10,000 kw.-hr. @ 0.04 ea.	$C = \$141.00 + 0.04e$ where $e =$ 10,000 to 20,000
All over	20,000 kw.-hr. @ 0.03 ea.	$C = \$341.00 + 0.03e$ where $e =$ 20,001 and over

Rate No. 2	*Formula*
Demand charge $2 per kw.	$C = \$2d + \$0.02e$ where $e =$ 0 to 1,000
1st 1,000 kw.-hr. @ $0.02 ea.	$C = \$5 + \$2.00d - 0.015e$ where $e =$ 1,000
All over 1,000 kw.-hr. @ 0.015 ea.	

Rate No. 3	*Formula*
Demand Charge	Kw. = 0 to 25
First 25 kw. @ $2.00	$C = \$2.866d + 0.006e$
Next 150 kw. @ $1.50	where e is greater than $124d$
All over 175 kw. @ $1.00	Kw. = 26 to 175
Energy Charge	$C = \$12.50 + 2.366d + 0.006e$
First 24 hours' use of demand @ $0.015 ea.	where e is greater than $124d$
Next 100 hours' use of demand @ 0.0125 ea.	Kw. = 176 and above
All over 124 hours' use of demand @ $0.006 ea.	$C = \$100 + 1.866d + 0.006e$
	where e is greater than $124d$

formula, we arrive immediately at the following forms:

$$C = 270 + 2.40d + 0.007e - 37.80 - 0.42d$$
$$= 232.20 + 1.98d + 0.007e$$

At this point, the equation begins to take a more definite form, and it is found that the cost for power each month, ignoring the power factor and fuel clause corrections, is equal to the sum of a fixed "customer charge" of $232.20 per month, a "demand charge" of $1.98 per kilowatt of monthly maximum demand, and an "energy charge" of $0.007 per kilowatt-hour of energy consumed. Since the fuel clause credit of $0.0005 per kilowatt-hour is to be applied before the power factor penalty, it may be applied directly to the energy charge, reducing it from $0.007 to $0.0065 per kw.-hr. The power factor penalty for a 70 per cent power factor would be $(80 - 70 \times 0.3) = 3$ per cent. The entire charge would be increased by this amount. The resulting cost would then be:

$$C = (\$232.20 + \$1.98d + \$0.0065e) \times 1.03$$

It is obvious that while the three principal charges of the rate are constant from month to month, the fuel clause and power factor corrections may vary as conditions change. It should be obvious, too, that if this rate schedule had included a prompt payment discount or a primary power service discount, which applied to the amount of charge, these discounts would affect each of the three principal charges in exactly the same manner as the power factor penalty shown in the last equation.

This example illustrates the derivation of a formula expressing only one particular form of rate. There are in existence a number of other types which may easily be reduced to a formula by following the same general method. In many cases, however, where there is a considerable variation in the monthly usage of electric power, and where the rate schedule contains a number of steps of both demand and energy charges, it may be necessary to work out several formulas, each one covering a usage falling in a definite number of steps.

In Table 1, several such formulas are shown, from which some idea may be obtained of their general nature. It is to be understood that they include only the fundamentals of the charges for power, and must be modified for any fuel, power factor, or other clauses.

After reducing the rate schedule to simple form, we may next proceed to prorate the power cost. As an example assume that the plant consists of four principal

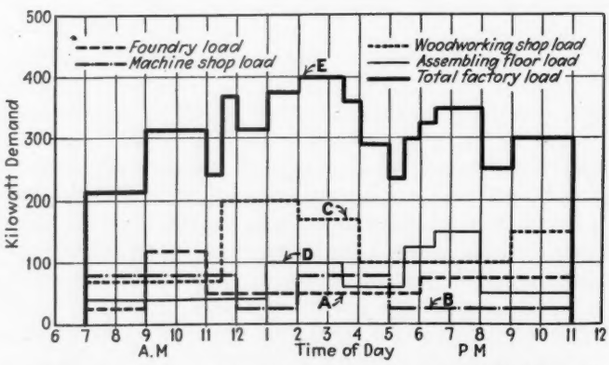


Figure 1. Daily load curves for plant of four divisions, illustrating diversity between individual load maximum demands

TABLE 2

Summary of Cost Allocation for Purchased Power

Cost of Power to Plant:			
122,000 Kw.-Hr.....	122,000		
400 Kw. Demand.....	5,400	@ $0.05	$270.00
80% Power Factor.....	116,600		
.5 Mill Fuel Discount...	24,000	@ $0.04	960.00
	92,600	@ $0.007	648.20
			$1,878.20
Fuel Discount.....			61.00
Net Cost for Power.....			$1,817.20

Rate Formula: Cost = $232.20 + $1.98 d + 0.0065e$
where d = maximum demand, and e = energy in kilowatt-hours.

	Foundry	Machine Shop	Wood Working	Assembly Floor	Total
Energy Usage, Kw.-Hr.....	25,375	21,000	47,750	27,875	
Energy cost @ $0.65....	$164.94	$136.50	$310.37	$181.19	$793.00
Max. Demand, Kw.....	120	80	200	150	
Kw. Diversity Factor.....	87.2	58.3	145.5	109	
Demand Cost @ $1.98....	$172.66	$115.44	$288.09	$215.82	$792.00
Customer Charge.....	$58.05	$58.05	$58.05	$58.05	$232.20
Total Power Cost for Plant.....					$1,817.20

departments—a foundry, a machine shop, a woodworking department, and an assembly floor, all operated with two eight-hour shifts.

Obviously, the energy requirements of each department may be determined by means of a sub-meter. The individual demands of each section may be determined either by demand meter attachments installed with the watt-hour meters or by special recording demand meters. The energy requirements of all four departments will equal the total energy registered on the main meter by which the plant is billed. The sum of the four individual maximum demands will not, in most cases, equal the maximum demand of the main meter because of the diversity between the four individual loads. Each load, however, contributes in part to the maximum demand of the plant, and therefore to a certain part of the total cost for power as determined from the demand term of the formula. This contribution to the maximum demand is usually termed the "peak responsibility" of the department, and the proper allocation of the power costs of each department depends principally upon its proper determination.

In the load curve of Figure 1 is shown, for example, a set of possible load curves for such a plant as we have mentioned. Curves *A, B, C,* and *D* represent the 15-minute demands of the foundry, machine shop, woodworking department, and assembly floor, respectively, for a representative day. Curve *E* gives the actual 15-minute demands for the plant as a whole for the same day. It will be noted that maximum demands for the day are 120, 80, 200 and 150 kw. The sum of these individual maximum demands is 550 kw., while the actual maximum demand of the plant as a whole is 400 kw. The ratio of the sum of the individual maximum demands to the actual plant maximum demand is known as the diversity factor. In this case the diversity factor would be 550/400 or approximately 1.375. It is obvious that the diversity factor can never be less than unity, in which case the maximum demand of each department would occur at exactly the same time as the maximum demand for the entire plant. In this particular case the diversity determined was that for a representative day. The diversity factor for the month or billing period could be determined by having a demand-indicating register upon each of the sub-meters. The ratio of the sum of the individual maximum demands for the four departments to the maximum demand of the entire plant for the month would give the diversity factor for the month.

With the diversity factor for the billing period determined, the peak responsibility for the period may be obtained by dividing the maximum demand of each department by the diversity factor. Each department's prorated share of the demand charge may be obtained by multiplying the peak responsibility of the department in kilowatts by the demand charge given in the rate formula, which in this case was $1.98 per kilowatt.

The total cost of power to be allocated to each department will consist of an energy charge equal to the total kilowatt-hours of energy consumed, multiplied by the unity cost per kilowatt-hour (in this case, $0.0065); and of the demand charge determined from the peak responsibility, as explained above. In addition to these two charges, there would still be a portion of the customer charge to be prorated. The total fixed charge for the whole plant as given in the formula was $232.20 for the rate schedule under discussion. Except in very small plants this charge would represent a small proportion of total power costs, and its effect upon the individually allocated costs would be small. Since it is a fixed charge for a single customer and does not vary either with the electrical load characteristics or with the purpose for which the power is used, its proration to the individual departments will depend principally upon personal opinion. The simplest method would be to treat it as a sort of operating tax, distributing it equally among the four departments.

A complete summary of the method just described is given in Table 2. In this example the power factor has been assumed to be 80 per cent, which would entail no penalty or credit under the rate schedule under discussion. For any other power factor, the three unit charges would be modified by the power percentage discount or penalty. In most cases it will be found that the power-factor penalties or credits are too small to make separate proration desirable. If not, and if the variation in power factor in the departments is excessive, the proration of these penalties or credits may be effected by installing the necessary meters.

In this example it has been assumed that all the power used could be definitely allocated to one of the four divisions. In most cases, however, there will be found such loads as water pumps or air compressors or electric railway facilities which are more or less common to all or several departments. Such loads should be treated as a separate division; their cost may be prorated according to the usage of the facilities which they provide.

Factory Management
and Maintenance

A consolidation of *Factory and Industrial Management* and *Maintenance Engineering*

L. C. MORROW, Editor

JUNE, 1933

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Industry Recovery Act

THE NATIONAL Industry Recovery Act, being sped through Congress as this is written, is revolutionary. Nevertheless it is being accepted by industry, on the evidence now available, with a fine spirit of cooperation—even gleefully, in some quarters. By the act, government enters further into business; but takes the step at the request of industry; and clarifies its position as it does so.

Industry has said for a long time, "Do away with anti-trust laws; let us regulate ourselves; we'll stop destructive competition, make conditions better for consumers of our products."

Government now says, "For a trial period of two years the anti-trust laws are suspended. Go ahead—regulate yourselves—but observe certain specific limitations. If you can't, or won't, regulate, we'll do so for you—it's a necessary job."

Among the limitations: No discrimination against smaller enterprises (Title I, Sec. 3-A-2; right of employees to organize and bargain collectively (Title I, Sec. 7-A-1); employees have their own choice as to joining or not joining labor organizations (*do,* -2); employers must comply with maximum hours of labor, minimum rates of pay, other working conditions that may be approved or prescribed (*do,* -3).

These are very definite limitations, *but* every opportunity is to be afforded "to employers and employees . . . to establish by mutual agreement, the standards as to the maximum hours of labor, minimum rates of pay, and such other working conditions as may be necessary in such trade or industry or subdivision thereof to effectuate the policy of this title."

Interpretations of the act are many. Presumably the Congressional and other discussions now taking place will determine which interpretations are approximately correct. Final interpretation and instructions will be issued by the Administrator of the act, to be appointed by the President. Indications are that the post will be filled by Hugh S. Johnson, in the soundness of whose judgment there is much well-placed faith.

An accepted interpretation of details is necessary before wide application of the act can be made—even before there can be much beneficial discussion at large. Immediately, however, certain provisions admit of no misunderstanding:

1. Success of the new industrial control will depend largely upon Trade Associations, which must have leadership of a very high order. Immediately after the act becomes law they will have to prepare agreements, codes of ethics, standards of practice for submission to the administrator. They will have to concern themselves with questions of wage rates, hours, production, prices.

2. The administrator will pass upon the agreement and standards proposed by Trade Associations. Hearings will give opportunity for minorities to present objections. Standards approved by the administrator will apply to the entire industry.

3. Failing agreement upon the part of an industry group, the administrator may establish the required standards and rules.

4. Finally, in the absence of satisfactory regulations otherwise established, the government may resort to licensing individual business units.

Study of the act leads to the conclusions that:

1. Management of the individual industrial plant will have much to do by way of revising policy and practice. Labor relations, hours of work, overhead, fixed expense, reserves for replacement, selling expense, selling price—the old familiars—will have to be examined in the new light. Standards of cost accounting within an industry will take on new importance.

2. Over-financing, from which much extraordinary competition arises, is not likely to get far if attempted, must not be permitted to occur.

3. Employers are to have new obligations to labor.

4. Labor is to have new responsibilities in self-government.

5. There is to be a different balance in the distribution of wealth—more to the bulk of population, which does the lion's share of consumer goods buying, less to holders of common stocks.

Trade Associations are to carry serious responsibility. For the best interests of their own membership and industry at large they should work toward the production of goods at lowest cost for lowest selling price in order to obtain wide distribution, on the base of acceptance of low but constant profit rather than feast and famine.

Trade Associations can prevent a return of profitless prosperity. Federal acceptance of codes of ethics and standards of practice will provide a usable weapon to stop unfair competition in whatever guise: selling below cost, starvation wages, misrepresentation, let-down specifications.

Perhaps the one thing that justifies worry is the opportunity offered to do the wrong thing about production and price. Except as to base commodities, such as oil, steel, cement, flour, and the like, it is hardly possible to assign quotas and set dollars-and-cents prices. Moreover, doing so leans toward the cartel method of distribution, which has shown great disadvantages, tends toward inefficiency and the destruction of enterprise.

With this thought of danger in mind, we suggest that in most industries it will be sufficient if the regulation is made that the manufacturer (distributor, dealer), after having lived up to all the proscriptions as to wages, hours, reserves, and so on, *must not sell at a loss,* measurement to be made on the business of a fiscal year. This simple regulation would maintain competition, which every American has been taught is fundamental, would avoid actual price fixing, and would encourage zealous search for better methods, better equipment, and better management.

NATIONAL INDUSTRIAL RECOVERY ACT—HR5664

[*Given are the principal sections affecting industrial plants*—Ed.]

TITLE I—INDUSTRIAL RECOVERY

DECLARATION OF POLICY

SECTION 1. A national emergency productive of widespread unemployment and disorganization of industry, which burdens interstate commerce, affects the public welfare, and undermines the standards of living of the American people, is hereby declared to exist. It is hereby declared to be the policy of Congress to remove obstructions to the free flow of interstate commerce which tend to diminish the amount thereof; and to promote the organization of industry for the purpose of cooperative action among trade groups, to induce and maintain united action of labor and management under adequate governmental sanctions and supervision, to eliminate unfair competitive practices, to reduce and relieve unemployment, to improve standards of labor, and otherwise to rehabilitate industry and to conserve natural resources.

ADMINISTRATIVE AGENCIES

SEC. 2. (a) To effectuate the policy of this title, the President is hereby authorized to establish such agencies, to accept and utilize such voluntary and uncompensated services, to appoint, without regard to the provisions of the civil service laws, such officers and employees, and to utilize such Federal officers and employees, and, with the consent of the State, such State and local officers and employees, as he may find necessary, to prescribe their authorities, duties, responsibilities, and tenure, and, without regard to the Classification Act of 1923, as amended, to fix the compensation of any officers and employees so appointed.

(b) The President may delegate any of his functions and powers under this title to such officers, agents, and employees as he may designate or appoint, and may establish an industrial planning and research agency to aid in carrying out his functions under this title.

(c) This title shall cease to be in effect and any agencies established hereunder shall cease to exist at the expiration of two years after the date of enactment of this Act, or sooner if the President shall by proclamation declare that the emergency recognized by section 1 has ended.

CODES OF FAIR COMPETITION

SEC. 3. (a) Upon the application to the President by one or more trade or industrial associations or groups, the President may approve a code or codes of fair competition for the trade or industry or subdivision thereof, represented by the applicant or applicants, if the President finds (1) that such associations or groups impose no inequitable restrictions on admission to membership therein and are truly representative of such trades or industries or subdivisions thereof, and (2) that such code or codes are not designed to promote monopolies or to eliminate or oppress small enterprises and will not operate to discriminate against them, and will tend to effectuate the policy of this title. The President may, as a condition of his approval of any such code, impose such conditions (including requirements for the making of reports and the keeping of accounts) for the protection of consumers, competitors, employees, and others, and in furtherance of the public interest, and may provide such exceptions to and exemptions from the provisions of such code, as the President in his discretion deems necessary to effectuate the policy herein declared.

(b) After the President shall have approved any such code, the provisions of such code shall be the standards of fair competition for such trade or industry or subdivision thereof. Any violation of such standards in any transaction in or affecting interstate commerce shall be deemed an unfair method of competition in commerce within the meaning of the Federal Trade Commission Act, as amended. A violation of any provision of any such code shall be a misdemeanor and upon conviction thereof an offender shall be fined not more than $500 for each offense.

(c) The several district courts of the United States are hereby invested with jurisdiction to prevent and restrain violations of any code of fair competition approved under this title; and it shall be the duty of the several district attorneys of the United States, in their respective districts, under the direction of the Attorney General, to institute proceedings in equity to prevent and restrain such violations.

(d) Upon his own motion, or if complaint is made to the President that abuses inimical to the public interest and contrary to the policy herein declared are prevalent in any trade or industry or subdivision thereof, and if no code of fair competition therefor has theretofore been approved by the President, the President, after such public notice and hearing as he shall specify, may prescribe and approve a code of fair competition for such trade or industry or subdivision thereof, which shall have the same effect as a code of fair competition approved by the President under subsection (a) of this section.

AGREEMENTS AND LICENSES

SEC. 4. (a) The President is authorized to enter into agreements with, and to approve voluntary agreements between and among, persons engaged in a trade or industry, labor organizations, and trade or industrial organizations, associations, or groups, relating to any trade or industry, if in his judgment such agreements will aid in effectuating the policy of this title with respect to transactions in or affecting interstate commerce, and will be consistent with the requirements of clause (2) of subsection (a) of section 3 for a code of fair competition.

(b) Whenever the President, after such public notice and hearing as he shall specify, shall find it essential to license business enterprises in order to make effective a code of fair competition or an agreement under this title or otherwise to effectuate the policy of this title, and shall publicly so announce, no person shall, after a date fixed in such announcement, engage in or carry on any business, in or affecting interstate commerce, specified in such announcement, unless he shall have first obtained a license issued pursuant to such regulations as the President shall prescribe. The President may suspend or revoke any such license, after due notice and opportunity for hearing, for violations of the terms or conditions thereof. Any order of the President suspending or revoking any such license shall be final if in accordance with law. Any person who, without such a license or in violation of any condition thereof, carries on any such business for which a license is so required, shall, upon conviction thereof, be fined not more than $500, or imprisoned not more than six months, or both, and each day such violation continues shall be deemed a separate offense.

SEC. 5. While this title is in effect and for sixty days thereafter, any code, agreement, or license approved, prescribed, or issued and in effect under this title, and any action complying with the provisions thereof taken during such period, shall be exempt from the provisions of the antitrust laws of the United States.

LIMITATIONS UPON APPLICATION OF TITLE

SEC. 6. (a) No trade or industrial association or group shall be eligible to receive the benefit of the provisions of this title until it files with the President a statement containing such information relating to the activities of the association or group as the President shall by regulation prescribe.

(b) The President is authorized to prescribe rules and regulations designed to insure that any organization availing itself of the benefits of this title shall be truly representative of the trade or industry or subdivision thereof represented by such organization. Any organization violating any such rule or regulation shall cease to be entitled to the benefits of this title.

(c) Upon the request of the President, the Federal Trade Commission shall make such investigations as may be necessary to enable the President to carry out the provisions of this title, and for such purposes the Commission shall have all the powers vested in it with respect of investigations under the Federal Trade Commission Act, as amended.

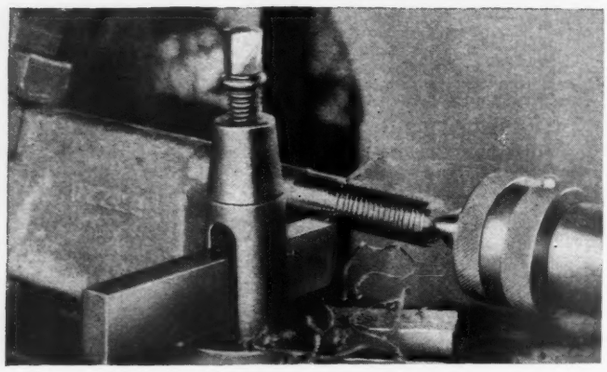
SEC. 7. (a) Every code of fair competition, agreement, and license approved, prescribed, or issued under this title shall contain the following conditions: (1) That employees shall have the right to organize and bargain collectively through representatives of their own choosing, (2) that no employee and no one seeking employment shall be required as a condition of employment to join any organization or to refrain from joining a labor organization of his own choosing, and (3) that employers shall comply with the maximum hours of labor, minimum rates of pay, and other working conditions, approved or prescribed by the President.

(b) The President shall, so far as practicable, afford every opportunity to employers and employees in any trade or industry or subdivision thereof with respect to which the conditions referred to in clauses (1) and (2) of subsection (a) prevail, to establish by mutual agreement, the standards as to the maximum hours of labor, minimum rates of pay, and such other working conditions as may be necessary in such trade or industry or subdivision thereof to effectuate the policy of this title; and the standards established in such agreements, when approved by the President, shall have the same effect as a code of fair competition, approved by the President under subsection (a) of section 3.

(c) Where no such mutual agreement has been approved by the President he may investigate the labor practices, policies, wages, hours of labor, and working conditions in such trade or industry or subdivision thereof; and upon the basis of such investigations, and after such hearings as the President finds advisable, he is authorized to prescribe a limited code of fair competition fixing such maximum hours of labor, minimum rates of pay, and other working conditions in the trade or industry or subdivision thereof investigated as he finds to be necessary to effectuate the policy of this title, which shall have the same effect as a code of fair competition approved by the President under subsection (a) of section 3. The President may differentiate according to experience and skill of the employees affected and according to the locality of employment; but no attempt shall be made to introduce any classification according to the nature of the work involved which might tend to set a maximum as well as a minimum wage.

(d) As used in this title, the term "person" includes any individual, partnership, association, trust, or corporation.

· MANAGEMENT SHORTS ·



Cuts Threading Time

Paddles for clay-mixing machines have to withstand considerable abrasive wear, are therefore made of 13 per cent manganese steel—hard to machine. It used to take an average of 2½ hr. to thread these paddles with ordinary cutting tools. With a tantalum carbide tool now available, the entire time for roughing and threading has been cut to an average of 9½ min. per finished piece.

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Moves sacks of sugar up a 30 per cent grade fast enough to satisfy anybody — that's what this conveyor is up to. Made of spiral tubes assembled in 8-ft. dual sections, it is portable. Flexible, too, because universal joints connect the sections

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Twenty electronic smoke recorders serve as Scientific guides to firing at the Duquesne Light Company's Colfax Plant, Cheswick, Pa.

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An electric furnace used in rolling phos-copper welding rods at 400 deg. C. cost $450, saved $750 on rejects during the first month's operation.

Shan't Pass

Ware can't pile up at the end of a certain belt conveyor at the National Enamel & Stamping Company, Granite City, Ill. Reason it can't: a photoelectric relay stands guard. Operators along this conveyor apply the beading to the ware, place it on a chain conveyor which takes it through the enameling furnace. Should a piece of ware get by the last operator, it interrupts the beam of light which in turn shuts off the conveyor motor. It starts again as soon as the operator picks up the ware.

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Carbon-Arc Soldering

Great savings in soldering costs have resulted in radio receiving set production at Stewart-Warner Corporation, Chicago, through the use of carbon-arc soldering. The soldering equipment consists of a pencil through which string solder is fed, and a terminal to which is attached a piece of carbon rod. The pencil and the carbon are connected to a low-voltage source.

The carbon is placed against the work, the solder on the joint. The current melts the solder and heats the joint, causing the solder to flow on smoothly and quickly. There is no smoke, less solder is used, nothing is hot except the contact point, the low voltage precludes injury to operators, the solder does not adhere to the carbon, and consequently no cleaning is necessary.

When a new model goes into production, both irons and carbon-arc soldering are used experimentally to find out just which joints are best adapted to each joint in the set. When the operation is finally standardized, the improvement of output and the other economies at the stations using carbon-arc soldering are noticeable.

PRODUCTION CONTROL

6. *Central Control Section*

Thomas M. Landy

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THIS SECTION maintains the dead load file and the master index, dispatches all orders and drawings to the various dispatch stations, operates the requisition progress file, the master control board—if there is one—and all master progress charts. It receives and issues all production information; carries on all correspondence with the customer.

In short, then, the central production control section is the contact between factory and customer, as well as the source of all data to the factory in conjunction with the planning section.

Dead Load File—This file comprises all orders already planned, for which paper has been prepared but for which the material is not yet available.

As the orders flow from the planning section, they are filed in the dead load file by material due date, and thereunder by drawing and part number. It can be seen at a glance just what material is late and what is arriving ahead of time, since the material slip is clipped to the order as soon as the material is received. This acts as a visual inventory control.

Hold-Up File—Along with dead load is also maintained a hold-up file, filed by shop order. Just as soon as a hold-up order is issued to the various dispatch stations, all orders are returned to the control section and placed in this file. In this way the status of a held-up order may be determined by looking in one place.

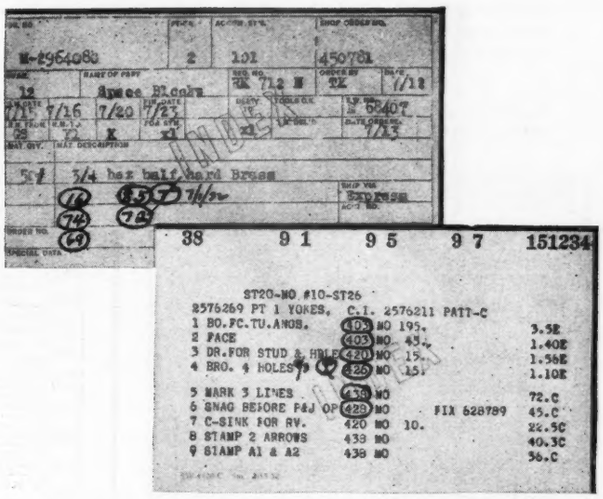
38 91 95 97 151234
ST20-NO #10-ST26
2576269 PT 1 YOKES, C.I. 2576211 PATT-C
1 BO.FC.TU.ANGS. 195
2 FACE 403 NO 45.
3 DR.FOR STUD & HOLE 420 NO 15.
4 BRO. 4 HOLES 426 NO 15.
5 MARK 3 LINES 438 NO
6 SNAG BEFORE P&J OP 428 NO FIX 628789
7 C-SINK FOR RV. 420 NO 10.
8 STAMP 2 ARROWS 439 NO
9 STAMP A1 & A2 438 NO

Figure 1. Showing notations on master index cards used with hectograph and mechanical methods of preparing factory paper

There are many obvious advantages in placing both the dead and hold-up files in one central location. Availability is one; another is in the fact that foremen and dispatchers are not bothered with orders not yet due or held up, or for which material is not available. Another very important thing in favor of this practice is that it ties up fewer drawings. Since each order must be accompanied by a drawing, it can readily be seen that to release orders ahead of time would only tie up that many more drawings.

Master Index—The next important function of this section is the maintenance of the master index. The green copy of the individual order (May, page 195) is sent from the planning section or service bureau (wherever paper is being made) upon the initial distribution and is immediately filed by drawing and part number. The index shows at all times the exact location of material and order. If the index is blank, it indicates that the order is waiting in the dead file. Likewise, if the order is held up, it will be so noted on the index.

The following code may be used in making notations on the master index card:

(BP)—Held up for drawing
(P)—In planning section
(D)—In defective hold-up file
(T)—Held up for tools
(H)—In hold-up file

When using these codes, notations are placed alongside the dispatch station number. Nothing should be erased. Instead, notations are crossed out when they no longer apply. Thus the circled *T* in Figure 1 indicates that the order was held up for tools. Crossing it out shows that the order has again been released. The date shows when it went to the dispatch station.

Every order going to or coming from the various dispatch stations, or being returned to the files or planning section, must pass over the master index. When the material has actually been delivered to the work station having the first operation, the move card is brought to the dead file clerk who attaches it to its order and draw-

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In the May installment of this series, we followed the preparation of the individual order and all necessary factory paper, and are now ready to observe the actual mechanics of production control as exercised by the central production control section

Figure 2. Simple changes of color—from pink to yellow to green to white—indicate progress of order

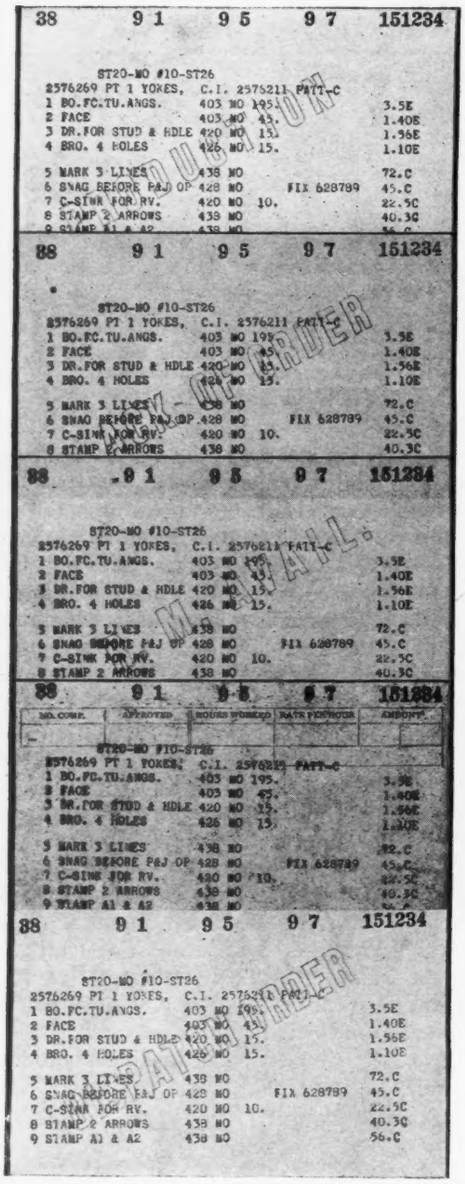

38 91 95 97 151234
ST20-MO #10-ST26
2576269 PT 1 YOKES, C.I. 2575211 PATT-C
1 BO.FC.TU.ANGS. 403 MO 195. 3.5E
2 FACE 403 MO 45. 1.40E
3 DR.FOR STUD & HDLE 420 MO 15. 1.56E
4 BRO. 4 HOLES 426 MO 15. 1.10E
5 MARK 3 LINES 438 MO 72.C
6 SNAG BEFORE P&J OP 428 MO FIX 628789 45.C
7 C-SINK FOR RV. 420 MO 10. 22.5C
8 STAMP 2 ARROWS 438 MO 40.3C
9 STAMP A1 & A2 438 MO 56.C
88 91 95 97 151234
88 91 95 97 151234
88 91 95 97 151234
88 91 95 97 151234
PRODUCTION ORDER
MATERIAL
PRODUCTION ORDER

Figure 3. A work station chart shows machine-tool loads

WORK STATION LOAD CHART

LARGE MACHINE WORK 1B

(ALL FIGURES ARE $ DIRECT LABOR) DATE 11-22

LIVE LOAD = MATERIAL AVAILABLE

DEAD LOAD = MATERIAL NOT AVAILABLE

CAPACITY =

NO.	MACHINE TOOL OR WORK STATION	CAPACITY	BACK LOG		11-29		12-6		12-13	
			LIVE	DEAD	LIVE	DEAD	LIVE	DEAD	LIVE	DEAD
300	LAYOUT WORK SMALL SIDE BAY		8		16	4	13		7	9
302	SCRAPE, BORE & FILE, KEYWAYS		34	19	5	6	12	8		
304	NILES BEMENT POND SLOTTER				7	3	6	1		3
305	CINCINNATI VERTICAL DOVE-TAILING SHAPER		79	15			9			
306	8' SELLERS BORING MILL		136	192			98			87
307	192" NILES BEMENT POND BORING MILL		3	28						
308	138" NILES BEMENT POND BORING MILL			22	13	7			13	55
309	8' CINCINNATI BICKFORD RADIAL DRILL PRESS		158	14	6	5	10	5	4	4
311	8' CINCINNATI BICKFORD RADIAL DRILL PRESS		36		9	7	4			8
312	6' KING BORING MILL			18			6			20
313	6' BULLARD MAXI-MILL									
314	5' BULLARD MAXI-MILL		83		8					8
315	5' BULLARD MAXI-MILL									
316	NILES BEMENT POND BORING MILL		12							
317	7' CINCINNATI BORING MILL		5					12		
318	DEFIANCE HORIZONTAL BORING MILL				7	4				
324	SELLERS 12'X13' PLANER			54	10	58	20	8	54	170
326	GRAY 30"X14' PLANER		32	1						
327	SELLERS 12' BORING MILL		91				33	10		2
329	8' CINCINNATI BICKFORD RADIAL DRILL PRESS		168	58		5	8	6	10	12
330	14' NILES BEMENT POND BORING MILL			45					41	
331	6' AMERICAN RADIAL DRILL PRESS									
332	14' NILES BEMENT POND BORING MILL		90	78	73			38		16
333	20" NILES BEMENT POND BORING MILL		49	153					8	
334	16' SELLERS BORING MILL								12	
335	16' SELLERS BORING MILL		64							
336	NILES BEMENT POND SLOTTER		186	57	2		5	7	4	4
353	INGERSOL DUPLEX MILLING MACHINE		71	20		13	4		16	26
355	GELTING & LEWIS DRILL PRESS		1							
356	7' CINCINNATI BICKFORD DRILL PRESS		100	10		33	9	12	7	7

M.G.-PROD. CONTROL DISPATCH STATION #4

ing, and sends it to the dispatch station. Each time a cycle of operations is completed in one dispatch station, the order and drawing must be returned to the master index before being sent to the next dispatch station. In very large factories with departments widely scattered it may be best to give each dispatch station its own dispatch order.

Requisition Progress File—We come now to actual control of production, which formerly involved "following" and all that that word implied. In one plant, in the East, with the installation of modern production control, there has been a reduction of 60 production followers. Another large plant doing a $12,000,000 business, all special, now follows its production with 5 men, and is keeping 100 per cent of its promises whereas before it kept but 48 per cent.

Upon the initial distribution of paper from the planning section or service bureau, a *pink* "production" copy is sent to the requisition progress file, where it is filed by shop order and thereunder by drawing and part number. Next is received the *blue* "acknowledgment of order" from the contributing department (in small plants this is unnecessary), or from the order and stores department, when material has to be ordered outside. When the material becomes available, the inventory control section sends the goldenrod "raw materials available" copy, which *replaces* the *pink* "production" copy. Then, as each operation is completed in the various dispatch stations, the "load deduction" copy of the *green* time voucher is sent to this file, replacing the *goldenrod* copy. Finally, the *white* "dispatch" order, stamped complete, is sent to the file, indicating the completion of the part.

Where there are no operations to be performed in the factory, such as parts bought outside or from allied plants, a *pink* "production" copy is delivered on the initial distribution as above, and is at once replaced by the *white* "dispatch" order when the part becomes available.

It will thus be seen that by simple color changes the exact status of an order in the progress file can be told at all times. See Figure 2.

By a very simple process, if desired, this requisition progress file may be exploded onto a master control board or requisition progress chart. These files and charts may be operated equally well under either the hectograph or the mechanical method of paper preparation.

Master Control Board—A board of this type visualizes the progress of requisitions in process and tells at a glance how certain parts are coming through the factory. It is useless and cumbersome in a factory making a diversity of products, especially when the manufacturing cycle is short. In other words, the parts will be completed before the paper can be moved on the control board. Likewise, it is uneconomical and unnecessary in factories building comparatively small stock quantities. It is, however, very helpful in the manufacturing of large apparatus or in mass manufacturing, where the failure to complete a single part on time will tie up the entire assembly line.

A master control board, or master progress chart, is nothing more than a visual presentation of the requisition progress file. The paper, of course, consists of the same copies which went into the progress file, and follows the same sequence.

For example, a control board used in a transformer factory making stock quantities, as well as a few specials, is set up on a due-date basis. Across the top are listed the days of the month—these might be changed to the first day of the week in factories operating on a longer manufacturing cycle. Down the left side are listed the various departments of the factory.

The *pink* "production" copies are placed on the board under the material date and against the starting department. Any *pink* copy which has not turned to *goldenrod* by the starting date shows at once that material is late. As soon as material is available, the *goldenrod* copy is moved to the pocket under the completion date. If it has not turned to *white* on that day, it shows that the foreman had not met his due date. These three copies are all that are used with this control board.

Another successful master control board is used in a large generator and motor department. Across the top are brass nameplates into which can be slipped shop order numbers. Down the left-hand side are listed the major parts of a generator and motor, followed by the foreman's name. Two separate boards are operated, one for d.c. and one for a.c. motors.

Work Station Load Chart—"Load" is the mortgage against a department of the factory and may be shown in man-minutes, man-hours, dollars, or points, depending upon the method of wage payment under which the department is operating.

There are many variations of the Gantt chart to show machine-tool loads. One that is easily operated uses a simple blackboard, and is illustrated in Figure 3. The work stations are listed down the left side of the chart with the dates across the top. Under each date are two columns, one showing the dead load, the other the live load. Factories with a very short manufacturing cycle may consider this division unnecessary.

Referring to the terms used on this load chart, "capacity" may be understood to mean the work which can be performed in one, two or three shifts depending on local conditions. "Work station" is the machine, group of machines, bench or floor location where certain work is to be performed. It is designated by number. "Dead load" is all work for which the material is *not* available. "Live load" is all work for which material *is* available.

In factories using hectographed orders, a copy of the original order is included with the group which goes to the voucher typists. After the vouchers are typed, they, together with the load chart copy, dispatch copy, etc., will pass to the load chart clerk, who records on the copy the number of each station involved and the predetermined value of the voucher covering the work at that machine or station. The value is also recorded on the voucher itself in the extreme lower left-hand corner and also on the dead load tally sheet under the proper machine heading. The order with attached copies and vouchers is then transmitted, as previously, to the chief dispatcher. The dispatcher files the load chart copy with the order and vouchers in the dead load file in the usual manner until the "raw material available" notice releases the order to a dispatch station. Then the dispatcher detaches the load chart copy of the original order and sends it to the clerk as evidence that the order has become live and should be subtracted from the dead and added to the live load.

When an order is completed, the voucher covering the work passes to the dispatch station clerks. The clerks, in addition to recording time in the usual manner, enter the amount shown in blue at the lower left-hand corner of the voucher on a suitable sheet, and make a check mark in red pencil against the blue figure. This serves to show that the voucher has been cleared from the live load and that the order is completed. The sheet on which the blue figure amounts are entered by the dispatch station clerk passes to the load chart clerk, who makes the necessary deductions from the live load shown against each machine or station number on the master load chart.

The load chart is readjusted once each week and a report is sent to each foreman, showing his live and dead loads for one month.

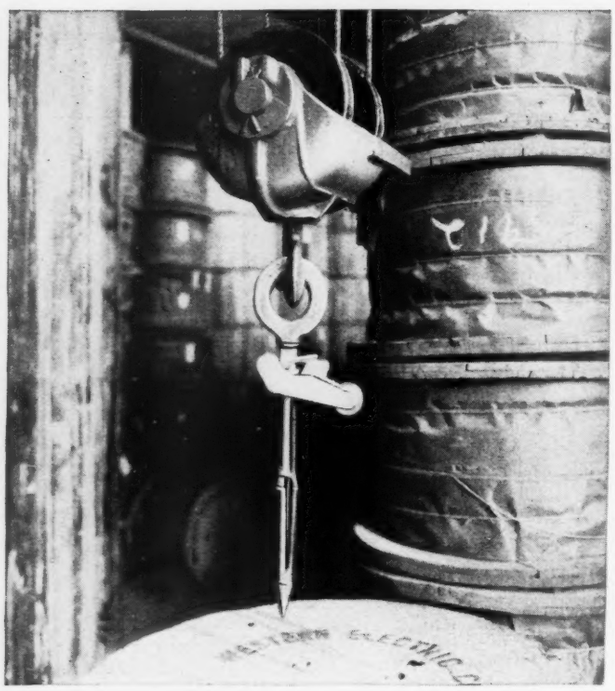
In factories using the mechanical method of paper preparation, all information appears on each form. It is only necessary, therefore, to send a copy to the load board clerk—for instance, the "production" copy on its way to the progress file. At this time the load is entered against the dead load. Upon receipt of the "material available" copy, the load is deducted from the dead load and added to the live load. Then as each operation is completed, the various dispatch station operators send the load deduction copies for deduction from the live load.

Under either method the load is recorded against the station and the date on which the work is to be completed at that station.

Inventories. What manufacturer does not have them on his mind? The problem is to set up a control that will not be too costly nor too complex. In the seventh article of this series Mr. Landy will discuss the work of the inventory control section and tie it into the broader function of production planning

·MAINT-O-GRAPHS·

Equipment efficiency • Ideas • Plant problems • Design developments



Umbrella-Like Device for Handling Cable Reels

SOURCE, Western Electric Company

Stacking of heavy, bulky cable reels has been simplified by the adoption of the unique device illustrated. When it is inserted through the hole in the center of a reel until the roller comes into contact with the reel head, the jaws spread and grip the edges of the hole. The reel is then picked up and set down in the desired location. In setting the reel down the roller is again tripped. This second trip closes the jaws and permits removal of the device.

More Convenience, Less Handling Because of Adjustable Shelving

What ordinarily would constitute aisle space is used to good advantage in the shelving arrangement shown. There are only two shelves between floor and ceiling, the floor under the shelves being used for filled barrels and other heavy items. The lower shelf, about 3 ft. above the floor, is for moderately heavy items, and the top shelf, about 7 ft. above the floor, is used to store the lightest materials. A man of ordinary height can pass under the top shelf readily when the lower shelf is removed in the aisle section.

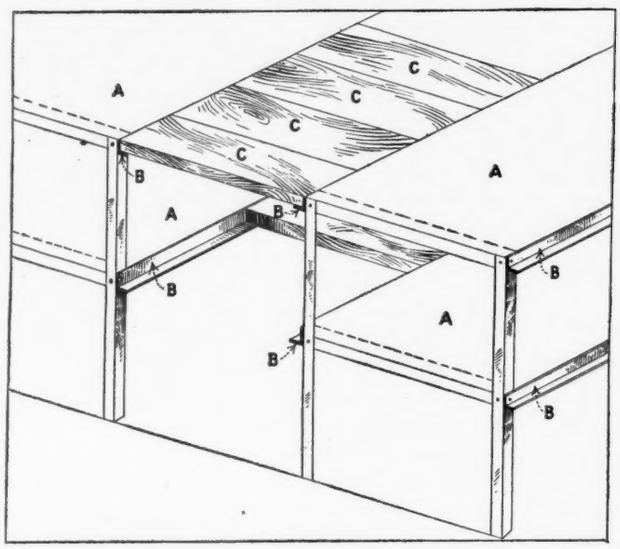
Units are made from angle iron, and may have four, six or more upright angles, depending upon the length and load to be carried. Shelves are of steel plate and rest upon horizontal angle frames to which they are fastened permanently. The width of the units is about five feet, and they are placed about that distance apart. Space between units serves for aisles when stock is low, so that shelves of the units themselves are easily reached and filled when stock arrives.

When the units are about filled and more stock has to be stored, the flexible feature of the arrangement is brought into play. It consists of boards about a foot wide cut to just the right length to fit between sections and rest at each end on the outwardly turned legs of the longitudinal angles of the frame. These boards are light enough to be handled easily and when not in use as shelves are piled on top of each other, still resting on the angles near the back end of the aisle, if the units are against the wall, or near the center if the units are placed so as to be accessible from both ends.

When extra shelf space is needed, the boards are placed as required, being filled as they are placed so that there is no need to reach far back. When stock is removed, the reverse process is followed.

Units that are light enough to be moved accidentally so as to increase the distance between them enough to permit the wooden strips to fall out, should be fastened to the floor or be fastened together above head level in such a way that shelves cannot drop. In some cases diagonal bracing to wall or ceiling may be required to prevent swaying. If a strictly fireproof structure is required, reinforced metal sections can be used in place of wood for spanning the aisle spaces.

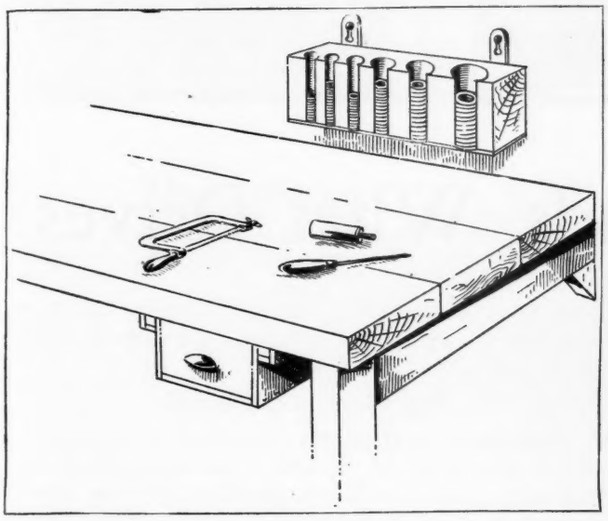
In case it is desired that the tops of the aisle sections



be flush with the tops of the metal unit shelves, and boards of adequate strength would be too thin to rest upon the angle and still come to the desired level, cleats can be used on the outer ends of the boards, or a strip of wood or metal can be fastened permanently to the angle in such a position as to bring the boards to the level desired. The letters in the illustration show permanent sheet-steel shelves *A*, longitudinal side angle *B*, removable sections *C*.

Wood Block Makes Convenient Washer Holder

CHAS. H. WILLEY, Penacook, N. H.



Bringing order out of chaos is the purpose of the shop accessory shown in the accompanying sketch. It is a washer holder that permits the storing of flat washers so that they are readily available and assorted as to size. Much time is saved in setting up jobs in drill press work by using a rack of this kind because it takes but a moment to reach for the desired washer. Furthermore, there is less danger of washers being lost when they are stored in such a holder.

To make the washer holder bore holes in a section of wood as shown. Add two clamps for wall fastening, and the job is finished.

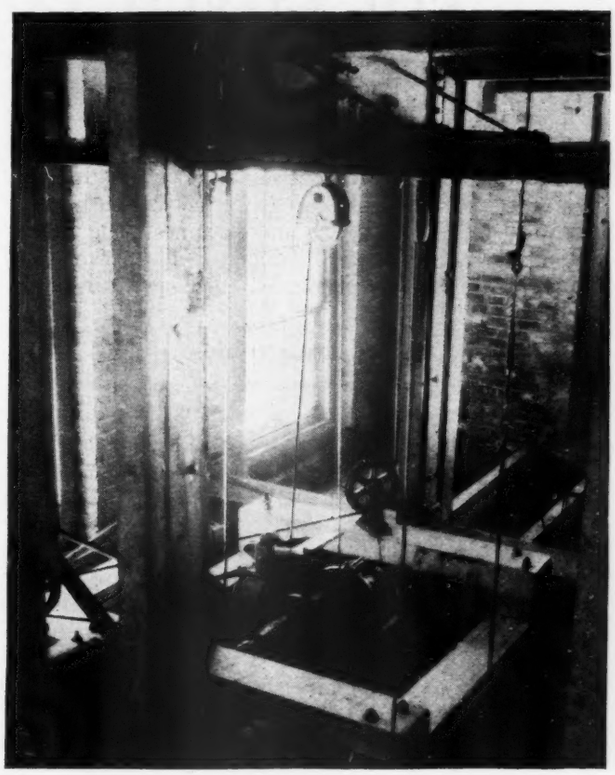
A Small Light for Big Jobs

WALTER WENDELKEN, Supervisor of Lighting Equipment
Westinghouse Electric & Mfg. Company, E. Pittsburgh, Pa.

An inexpensive miniature spot light for shop maintenance work can be constructed by taking one of the ordinary fountain-pen type flash lights, mounting it on a flexible cord and arm, energizing the lamp with a small transformer, and mounting the swinging arm over the shop work bench. This small light will save considerable time and expense by enabling thorough inspection of bearings and oil rings and other small parts of motors

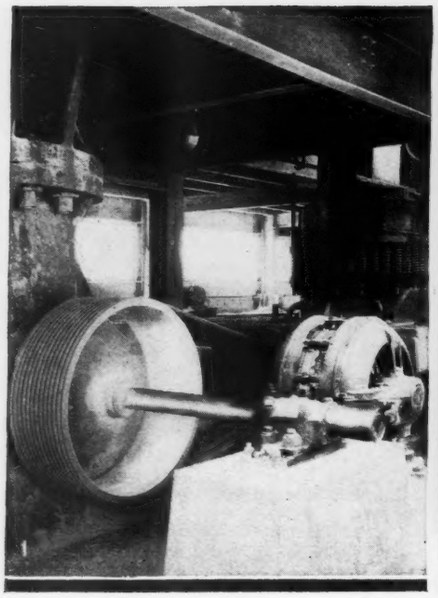
and equipment. By locating the trouble before entirely disassembling the apparatus considerable time can be saved.

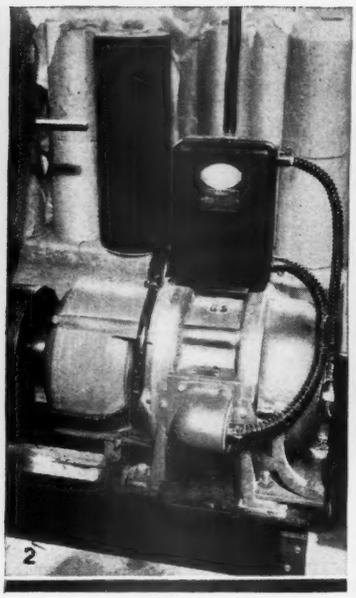
Spare Hoist Used for Elevator

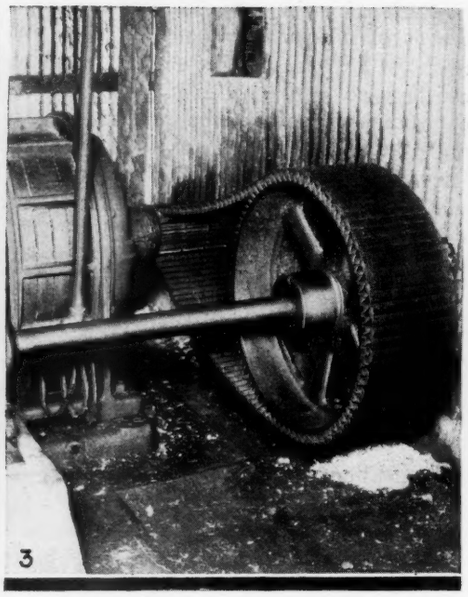


For some time the Bigelow-Sanford Carpet Company was in need of a light freight elevator for transporting hand trucks between floors. Also for some time it had on hand a spare 1-ton electric hoist.

Finally the two were put together, and the result was the freight elevator illustrated. It is controlled by push-buttons and limit switches so that no operator is required and nobody is permitted on the elevator. A 7x4½-ft. platform operates between the guides as shown.







For Given Loads, What Drives?

IN CHOOSING a motor drive for a specific machine, there must be taken into account the electrical and mechanical characteristics of the motor, motor control, and the method of connecting the motor to the load. This article considers the connecting devices to be used with various types of motors and machines. The accompanying diagrams are not infallible or all-inclusive, but represent many of the conditions encountered in actual service.

Motor Characteristics

Squirrel-cage motors started on full voltage come up to full speed in a fraction of a second; the torque thus created is very high. For this reason, belts, gears, or chains should be used with discretion, especially where the driven machine has a high breakaway torque or a heavy flywheel characteristic.

Squirrel-cage motors started on reduced voltage take several seconds to come up to full speed, because starting is accomplished in two or more steps. Since motor torque varies as the square of the applied voltage, reduced-voltage starting puts much less strain on driving mechanisms than does full-voltage starting. For instance, 65 per cent voltage produces only 42 per cent torque.

Wound-rotor induction motors are always started with resistance in the secondary winding, the resistance being gradually cut out to bring the motor up to speed. As a result, the torque transmitted to the driven machine through the driving mechanism is entirely under the control of the operator.

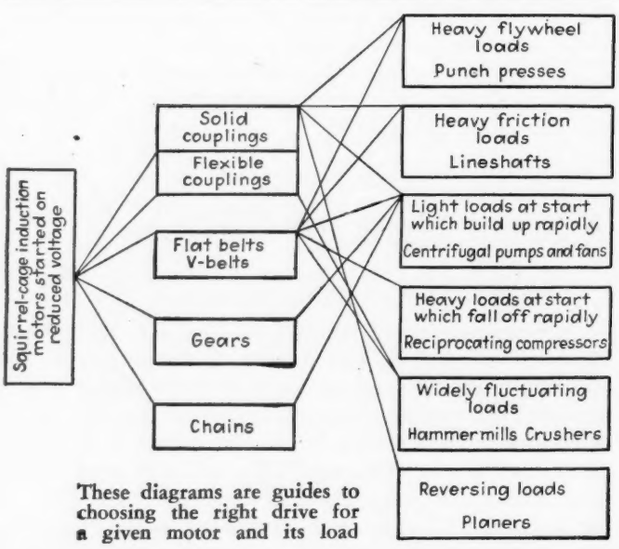
Direct-current motors are always started with low voltage in the armature circuit. The same comments apply to these motors as to wound-rotor induction motors.

Alternating-current brush-shifting motors are normally started with the brushes in the low-speed position, which gives a low starting torque. When they are started with the brushes in any but the low-speed position, secondary resistance is usually applied to limit the starting current and torque.

Transmission Characteristics

The primary function of a mechanical power transmission is to transmit to the driven machine, with as little loss as possible, the power developed by the driving motor. A secondary function is to protect the machine and the motor from each other.

Couplings, in general, are used in drives where the motor and machine shafts are in line, and where both units are on a substantial common base. Solid couplings can be applied to drives of almost any type. Consideration must be given to the fact that motor and machine



These diagrams are guides to choosing the right drive for a given motor and its load

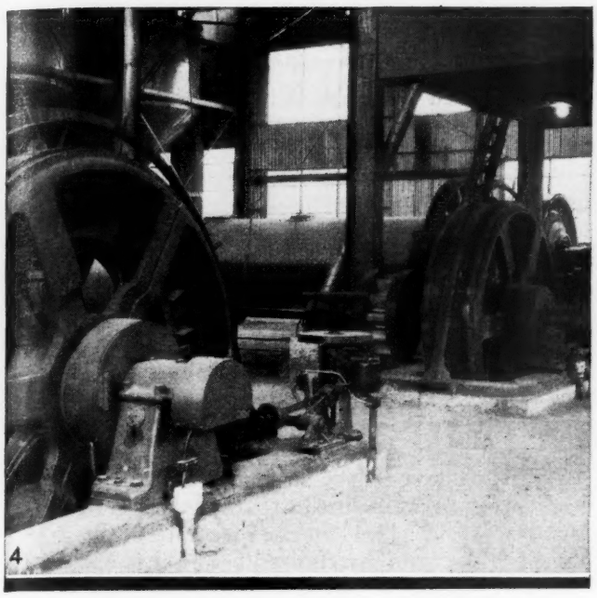


Figure 1. Gyratory and cone crushers in a Tennessee plant are driven by squirrel-cage induction motors through multiple V-belts

Figure 2. Doubling calender at Acme Backing Company, Brooklyn, N. Y., driven by gear motor. Speed changes from 900 to 90 r.p.m. are possible

Figure 3. Squirrel-cage induction motor with silent chain is used for the main drive in a Texas cotton gin

Figure 4. At Volunteer Portland Cement Company, Knoxville, Tenn., synchronous motors with automatic brakes drive raw and finish grinding mills through flexible couplings

H. M. French

Industrial Engineering Department
General Electric Company, Schenectady, N. Y.

shocks are transmitted without cushioning; in some cases, high maintenance costs may result.

Flexible couplings are recommended where the load fluctuates widely, as on hammer mills, or where the motor or machine may be subjected to sudden shocks. This type of coupling cushions the shocks. It also permits a limited amount of misalignment.

Flat belts are rarely objectionable from the transmission standpoint. Shafts do not need to be exactly parallel. Belts do not transmit shocks and will slip on excessive power peaks, thus saving damage.

Where flat belts are to be used on short centers, idler pulleys are often applied. In starting heavy inertia loads, such as long lineshafting systems, the idler can be raised to reduce the current drawn by the motor. After the motor has reached full speed, the idler is slowly returned to normal position.

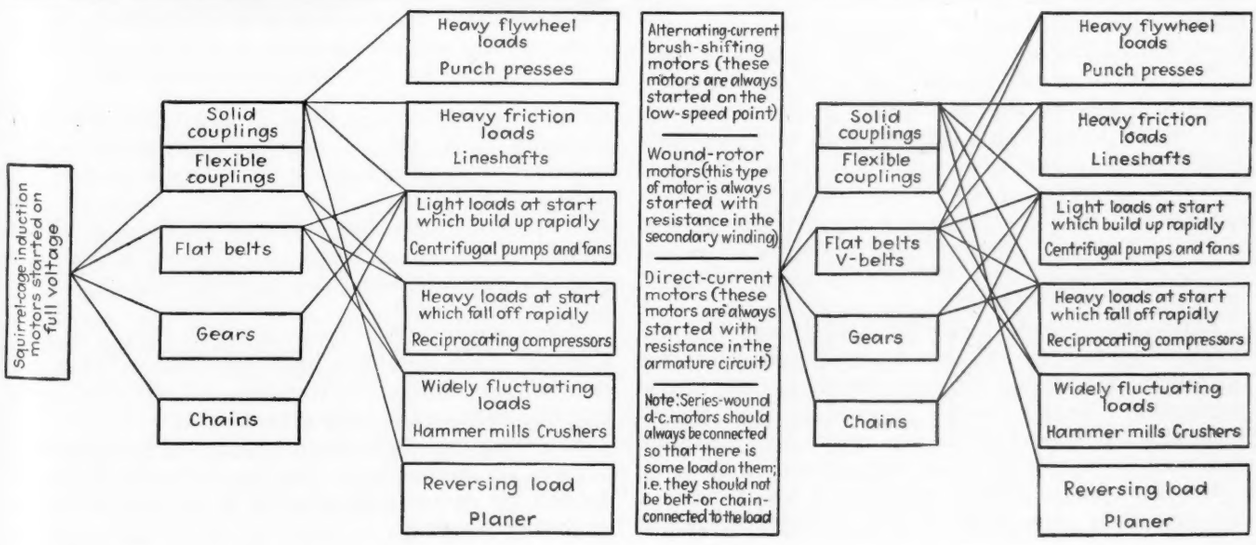
The pivoted-motor-base drive, making use of the flat belt, finds considerable application for short-centers. It employs a motor mounting free to swing about a pivot shaft. The weight of the motor automatically changes the center distance to provide uniform belt tension.

Multiple V-belt drives have proved to be good transmitters of power, with low slip, where short-center distances are involved. If one of the belts breaks, it is not necessary to shut down the machine at once.

Gears. In many cases, normal motor speeds are too high for direct connection to industrial machinery, and positive speed-reducing equipment is required. The speed reduction which can be obtained is almost limitless; space required is small; no moving parts are exposed; lubrication is simplified.

A recent development in gear drives has been the combination of standard motors and speed reducers into units called gear motors. Output shaft speeds of from 600 r.p.m. to 13 r.p.m., and lower, can be obtained. These units combine high efficiency of normal-speed motors with the compact construction of the internal helical-gear planetary type of speed reducer.

Gear motors are readily adaptable to machinery of widely varying design. They may be furnished for horizontal, flange, or vertical mounting; with special electrical


Squirrel-cage induction motors started on full voltage
Solid couplings
Flexible couplings
Flat belts
Gears
Chains
Heavy flywheel loads
Punch presses
Heavy friction loads
Lineshafts
Light loads at start which build up rapidly
Centrifugal pumps and fans
Heavy loads at start which fall off rapidly
Reciprocating compressors
Widely fluctuating loads
Hammer mills Crushers
Reversing load
Planer
Alternating-current brush-shifting motors (these motors are always started on the low-speed point)
Wound-rotor motors (this type of motor is always started with resistance in the secondary winding)
Direct-current motors (these motors are always started with resistance in the armature circuit)
Note: Series-wound d-c. motors should always be connected so that there is some load on them; i.e. they should not be belt- or chain-connected to the load
Solid couplings
Flexible couplings
Flat belts V-belts
Gears
Chains
Heavy flywheel loads
Punch presses
Heavy friction loads
Lineshafts
Light loads at start which build up rapidly
Centrifugal pumps and fans
Heavy loads at start which fall off rapidly
Reciprocating compressors
Widely fluctuating loads
Hammer mills Crushers
Reversing load
Planer

characteristics such as high starting torque and low starting current; and with special mechanical features for use in hazardous locations.

Chain drives are positive and permit the use of very short centers. They are not affected by conditions of atmosphere or environment, and can be operated at relatively high speeds. Accurate parallelism of shafts is not essential, though there is not the element of flexibility that is found in belts.

Load Characteristics

Flywheel loads are of two types. One is the machine to which a flywheel is added to improve operation; the other is the machine which, because of its construction, inherently forms a flywheel load.

The addition of a flywheel to any load having a fluctuating power requirement, such as punch presses, shears, reciprocating compressors, etc., equalizes the load, reduces the power demands on the motor, and makes it possible to use a smaller motor.

Because of its high inertia, a flywheel or a flywheel load resists a change of condition of rest or motion. When it is in motion, it possesses energy that is the square of the weight and the square of the speed. It absorbs energy when the speed is increasing and delivers it when the speed is decreasing.

To drive machines having a large flywheel effect or having an attached flywheel, motors should be chosen which have a high slip at full load. This permits the motor to slow down under heavy load and allows the flywheel to do its work. This procedure relieves the transmitting mechanisms of sharp peaks and tends to reduce maintenance cost.

Where squirrel-cage motors, started on full voltage, are applied to flywheel loads, the use of flexible couplings or a non-positive drive is recommended. Care should be taken to choose a motor which has a high heat-storage capacity, because several seconds will be required to get the flywheel up to speed. Where motors with flywheel loads are to be started on reduced voltage, flexible couplings or flat belts may be used, but, since the starting torque can be applied gradually, positive drives can be used if care is observed in starting.

Friction loads. The power required to start a friction load depends upon the newness of the machine, the length of time it has been shut down, the condition of the equipment, and whether or not there is a heavy working load.

The type of power transmission to be used depends upon the breakaway torque involved. Where this torque is extremely high, as in heavy machinery which has been shut down for a long time, it is almost imperative to use a positive connection, preferably a flexible coupling.

Unless the motor torque is built up carefully, gearing or belting may suffer damage. Such friction loads as conveyors are usually driven through gears either in gear units or built into the motor.

Light load at start. Centrifugal pumps and fans are outstanding examples of loads which start light, but on which the torque increases rapidly as the motor accelerates. The horsepower required to drive a centrifugal pump or fan varies as the cube of the speed; this fact must be considered in selecting motor and drive.

Usually, where no speed reduction is required and a self-supporting common base is used, a solid coupling will serve. There is no particular strain in starting, and the load is steady so that the cushioning effect of a flexible coupling is not needed.

Where speed reduction or increase is required, a belt or chain drive will serve the purpose.

Heavy load at start. A reciprocating compressor starting under load (i.e., with valves closed) requires a high starting torque which falls off rapidly as full speed is reached. The same is true of reciprocating pumps, ball and tube mills, loaded conveyors, etc.

These drives require high-starting-torque motors, and for this reason a flexible coupling with gearing or a V-belt drive is nearly always used. For small reciprocating compressors, in particular, flat belts (with idlers) or multiple V-belts are very often used because of the torque involved; also because these drives nearly always operate on short centers.

Where reduced-voltage starting is used, the shocks in gears or chains are reduced to safe values. However, the necessity for the added expense for reduced-voltage starting should be carefully checked before it is applied.

Widely fluctuating loads. Crushers and hammer mills provide good examples. In some cases, these mills are equipped with flywheels, and the comments under flywheel loads will apply. Their starting torque is not usually particularly high except where the mills are stopped with material in them, in which case it is often necessary to dig the material out before starting. For this reason, squirrel-cage or wound-rotor motors are usually applied.

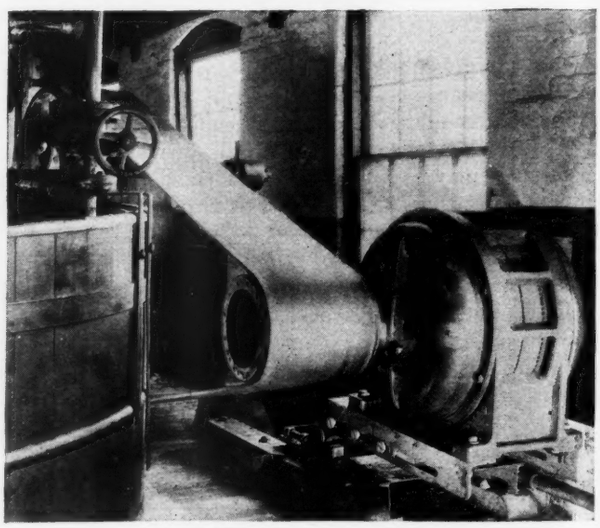


Figure 5. A squirrel-cage induction motor on a pivoted base is employed to drive this beater in a paper mill

With crushers, flat-belt drives are widely used. Speed reduction is often necessary; in addition, a belt drive prevents fluctuations and shocks from being transmitted directly to the motor.

For hammer mills, direct drive through a flexible coupling is the rule. The high speed makes direct connection easy; shocks and vibrations are absorbed in the coupling and not transmitted to the motor.

Reversing loads. For rapid constant-reversing service, such as the metal planer, present practice is to direct-connect the motor to the machine through either a solid or flexible coupling.

· FACTORY FORUM ·

A new question is presented herewith, and readers' discussions of previous questions are published. Write down your opinions and send them to the editor. Answers published will be paid for

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What Will a Shorter Day Mean to Maintenance?

On the golf course. It's Saturday afternoon, the links are crowded. George Shipman and Frank Fulleger have frequent waits at tees and on the fairways.

* * *

"This waiting is what spoils golf for me, George. I get my muscles all nicely coordinated and then have to hold back; and I find my shoulders hunched up for the ball that's going to drop from behind."

"Never mind, Frank. Wait until we have the six-hour day. Be plenty of time for everybody to play during the week then. We'll spread the golf as well as the work."

"Are you kidding me, or am I just laughing? I never knew a maintenance head who could be sure of working a given eight hours and then going home—let alone six. So I'll be on the job plenty, you bet."

"I don't get you. You won't be able to work your men overtime, you know. And you can't put in a twelve-hour day to supervise two shifts. How would you work it, anyway? In all the talk about six-hour days and thirty-hour weeks I haven't heard any statement about how to handle maintenance."

"I've been thinking a lot about it, George. I know part of the problem, but none of the answer. Here are some of the posers: How many maintenance shifts if we run one production shift? How many if we run two production shifts? If more than one shift, shall they overlap? Will routine inspection and upkeep operations now done for every eight hours of work have to be done for six, or for twelve? How will our power service meet requirements if we increase our force one-third and divide it into two shifts?"

"Drive off, Frank; they're far enough ahead and we'll be holding up the game if we don't get started." Frank drives, so does George, and as they walk together a hundred yards or so before separating to follow the diverging courses of their balls: "I'd like to sit in with you on those questions, and some more, too; you haven't mentioned a lot that occurred to me as you talked. Let's get together soon."

"Okay by me, George—sooner the better."

* * *

The game goes on, but the discussion doesn't. It's our opportunity.

What will the six-hour day, thirty-hour week, mean to maintenance?

•

ANSWERS TO PREVIOUS QUESTIONS

Job, or Job Plus?

(Question presented in the May issue)

DURING the prosperous post-war days, many plants expanded to the point where department heads and executives became super-self-centered in their particular phases of plant operation. This condition, fostered possibly by the necessities of the times, was not and is not conducive to full cooperation. As a result of this industrial era, many small plants grew into large ones and lost the benefits of the general knowledge each keyman formerly had of the organization as a whole.

Many competent men now are unemployed because they were content to rest on their oars after they had successfully mastered their functions. When retrenchment became necessary, jobs were combined, and if Jones could do two or three types of work moderately well, he was retained; while Smith, who was an excellent specialist, was released. So much for the employee's basic reason for extending his endeavors, even though not required. The company is also vitally affected by men who make themselves valuable to the extent of occa-

sionally straying to the other man's pastures. For instance, proper knowledge and consideration of a new product by the maintenance engineer may cause him to suggest changes in the proposed process set-up, which will lower maintenance costs permanently on the equipment involved.

Maintenance engineers now are handling production, and vice versa; production men may be handling purchasing as well as production; the purchasing agent may now be the production man, and so on. The same holds good for the superintendent, the personnel chief, the chemist, and even the works manager. Each is adding to his personal storehouse of knowledge, and when business is again prosperous will benefit his concern and himself in even a larger measure.

With the heyday of mad spending over, the consumer is spending wisely and cautiously. The cooperation of each key man is required to attain the ultimate goal of every manufacturing concern, namely, CONSUMER SATISFACTION AT A PROFIT TO THE COMPANY. Common knowledge of the basic principle of the other man's work is essential to provide the checks on all possible errors, and the shortcuts necessary to enable a profit to be shown. With present industrial tendencies, it most certain behooves the factory executive to broaden his knowledge of all possible operating phases.

L. P. WEINER, *General Superintendent*
The American Products Company
Cincinnati, Ohio

What Is the Plant Man's Responsibility Toward Sales?

(Question presented in the March issue)

THE PLANT man plays an important role in the sale of any article. He is acquainted with the manufactured article from the beginning of its career as raw material to its finish as a usable article. On him depends, in great measure, the time expended in making the article, the cost of producing it, its quality, and its utility.

It is the plant man's duty to search for new equipment or machinery, and to recommend its purchase. He must be able to decide that such purchase will be a real gain.

He is constantly on the lookout for new economies, both in cost of equipment and in the handling of the article. This part of his job requires a constant lookout for the little things that go into the making of an article, little things which ultimately decide whether the consumer pays a dollar or two dollars for it.

WILL HERMAN, *Superintendent*
Tannenbaum Oil Company
Cleveland, Ohio

THE PLANT man's responsibility toward sales is of a primary nature. He must at all times produce a uniform quality product; keep production promises 100 per cent or better; standardize production costs; be on the alert for method improvements and for new equipment whereby to reduce costs.

As a rule the plant man knows which are the best raw materials and consequently should work in close cooperation with the purchasing department in specifications, keeping in mind that the raw materials that make up the finished product determine to a large extent its salability.

K. N. BERGSBAKEN, *Assistant Superintendent*
Anson-Gilkey & Hurd Company
Merrill, Wisconsin

How Much Efficiency Now?

(Question presented in the April issue)

THE MAINTENANCE engineer who lets down while orders are few is comparable to the athlete who breaks training. He faces a harder grind to regain lost ground and the possibility of not being at peak when the big test comes—as it always does.

So, with the plant as a whole, to stand still is to fall behind those competitors who have kept on their toes.

Unfortunately, the idea of an improvement holiday not only injures the plant foolish enough to adopt it; it retards the general business recovery we are all devoutly hoping and working for.

Are small savings justified? To answer that question one has only to see—as I have seen—the careful manner in which time studies of manufacturing operations are being scrutinized in large and small plants alike. Micromotion study has been used on operations that were formerly considered incapable of yielding a saving, and the end has always justified the means.

So our mutual friend Frank would be well advised to get back on the job and forget about letting down. On the contrary, if he makes a more intensive survey of plant conditions, he will find blind spots on his maintenance horizon which, properly attacked, will justify the effort expended on them. Not only will plant efficiency be enhanced, that intangible yet priceless asset—morale—is bound to be sustained and strengthened.

ROBERT S. ALEXANDER
Special Department
Universal Winding Company
Auburn, R. I.

NEITHER the plant nor the individual is justified in letting down when orders are few. When the plant is running full speed, the maintenance foreman, for example, should be alert for opportunities to effect savings.

Ideas and suggestions for savings should be recorded at all times and referred to when orders are few. If left to memory they are likely to be forgotten; the rush comes and we have accomplished nothing during the slack moments.

Over a period of time a large amount of savings can be made. Each B.t.u. and kw.-hr. we can save results in large returns for the company.

There is not a machine made or operation performed on which there could be no improvements. Waste in industry and inefficient operation are still great enough to attract our attention.

C. B. SCHAFER, *Master Mechanic*
Safety Glass Plant
Libbey Owens Ford Glass Company
Toledo, Ohio

Why a Purchasing Department?

Edward T. Gushée
Purchasing Agent

and

E. P. Lovejoy
The Detroit Edison Company

Can anyone with reasonable intelligence buy well enough? Or is a purchasing department necessary? Plant managers may obtain their answers to these hardy perennials by referring to the check sheets on the two pages that follow

IN EVERY organization, large or small, there is a body of opinion which believes that the individual who requires materials or supplies can do just as good a job of buying for the company as can the purchasing department. This is a very natural human reaction. Everyone has had some experience in buying for personal or corporate needs; moreover, there is a very distinct "ego satisfaction"—if we may borrow a term from modern psychology—in placing an order for goods. The conferring of a favor upon a salesman in the shape of an order makes us all feel a little superior. This makes the act of purchasing a desirable one. It is power—and we all love power.

If it is a fact that any individual, in any department, is as capable of negotiating as satisfactory a purchase as the purchasing department, then there is no real necessity for such animals as purchasing agents or buyers. Their function can be performed within each department and a stenographic bureau set up for the typing and follow-up of orders.

The average purchasing agent or buyer feels that the case for centralization in a purchasing department is fairly well proved, because he can point with pride to this deal or that deal where he has safeguarded the company's interests. He can point to those occasional incidents where a plant superintendent stepped out of character long enough to contract for a carload of French wastepaper baskets or Swiss steel under the assumption that he was buying one or two wastepaper baskets or a foot or two of steel. However, a buyer is just as human as any other employee of the company, and if the average intelligence is about the same, will not the law of averages operate to the extent that he will be as fallible as far as the ordinary run of human errors goes? If there is no necessity for particular training for this buying job, the buyer will make approximately the same percentage of good deals as his confrere in some other department. But—and this is a particularly important specification—if real training is necessary for efficient results in buying, then—and then only—is there a real necessity for a highly organized buying group.

Also, we are apt to forget in buying for our companies—whether the individual concerned is within or without the purchasing department—that we are mere instruments of our companies and that it is not Otto Zilch, the buyer, or Mr. Whosis, the plant superintendent, who is personally conferring an order on the salesman.

The heart of the problem is this: Is purchasing simply a casual discussion with a number of salesmen as to quality of product or price or delivery, or does efficient buying require the consideration and careful weighing of any other factor or factors?

A group of buyers were asked to list in detail the things which they had either to consider or to take direct action upon in issuing a representative number of orders. This list was to include not only the consideration of those factors generally thought of as inherent in a purchase, but the other routine factors necessary to safeguard the company in the payment of invoice, in the receipt and inspection of materials—in short, those functions covered by the broad term "procurement."

The compiled list from several buyers was arbitrarily divided into these subdivisions: preliminary, quality, service, cost, and final. There is no merit in attempting to set up any one of these subdivisions as more important than the other, but it may well be said at this point that cost, while not as simple as it seems because of its inclusive characteristics, is more tangible than quality and service. Hence it may be arrived at more easily.

It should be clearly understood that these are routine functions and do not provide for nor mention the underlying brain capacity of the buyer or purchasing agent which is called into play for some purchasing. In almost any purchasing there is an opportunity and a compelling necessity for exercising judgment. As soon as

140 REASONS FOR A

PRELIMINARY

Item or Material

Is the item described correctly and sufficiently?

Is the same item, described perhaps in a different manner, stocked by the stores department, or could it be secured from salvage?

Have we other materials in salvage which might be altered and thereby adapted to the job?

When is the material required?

Does the quantity specified fit usual production or distribution practice? (i.e., standard package, carton lots, carload lots, etc.).

Has the item specified characteristics that narrow down the competitive field, that cause manufacturing difficulties, or that put it into the class of a specialty? If so, why?

Vendor

Should reciprocity of business enter into the selection of the vendor?

What would be the most economical numbers of sources for us to have? (Considering the relation of our purchases to the whole market and our service needs.)

Should competition on our account be widened through development of new sources?

Should the number of sources be limited to keep the account profitable?

Have you checked all your available sources of information on possible vendors? (Sweet's Catalog, Thomas' Register, etc.)

Correlate orders to the same vendor—especially for phone placement.

Should the order be sent to the agent or direct to the central office?

If we are buying through an agent, what is the reason, and has that reason been checked recently?

If vendor is specified by requisitioning department and is not satisfactory to buyer, talk to department before making a change.

Order

Should the item be purchased on an existing "blanket" order?

Should the clauses for "Workmen's Compensation," "Mechanics' Lien Law," "Report to the Superintendent," "Public Liability" protection or "Property Damage" protection be put on the order?

If there is no specification, should there be one?

Is there some standard reference by which material can be definitely specified? (Detroit Engineering Society specification on sand and pebbles.)

In case of a specification, is it possibly too rigid?

Are the required samples, prints, or specifications available for obtaining quotations?

When the order is placed, will prints be referred to—if so, are they available?

Is required quantity of such proportion with relation to output of any one source to warrant splitting order so as not to jeopardize service?

Procedure on yearly discounts.

If purchase deals with a patentable matter to the development of which the company has contributed its time or money, have patent rights been adequately protected?

Requisition

Is the requisition signed by an authorized person?

What further descriptive clauses must be added?

Are you sure that the address on the requisition or on your record card is correct?

Is requisition confirming a verbal order?

Is work order shown?

Notify user if unable to meet delivery date shown.

Sort for consolidating two or more requisitions on one purchase order.

QUALITY

What particular characteristics or qualities must the item have to fill its intended use?

Is the same item specified that was purchased for that use before?

If a different material is being specified, why has the change been made?

Is a different item being specified for this use by other departments?

Is any other item on test that should be checked at this time?

Should special inspection be made (i.e., by Inspection Division) or is it sufficient to rely upon the casual inspection made by user at time of use?

If inspection by regular inspector, when? During manufacture, before shipment, after receipt, or after installation?

Is the *kind* of material economically correct for the purpose (lumber, etc.)?

What other qualities are available?

Is the quality specified too good for the purpose or perhaps too poor?

Can a substitution be made of another brand of the material of satisfactory quality at a price saving?

Can a better material be suggested to the requisitioner?

If a change in quality is being made, how serious will the results of a failure be?

Has this item been standardized, and if so, does it conform to the standardization description? Should it be standardized? Can a standard article be substituted?

Have we a specification covering this item? Is specification too restrictive?

Have you seen any advertisements of promising substitutions in trade journals or miscellaneous literature, or have you heard any such materials discussed at various technical meetings?

Should any clauses regarding guarantees be inserted or a request for a written guarantee be made? Performance bond?

SERVICE

Are you sure that you are purchasing the material from a suitable vendor?

Relatively how important are our orders to the concern manufacturing the material, if it is in the nature of a specialty?

Can more advantageous purchase be made if requirements are predicted further in advance in order to take advantage of more distant sources or of those where unusually long delivery is offset by lower price or higher quality?

Does the necessity and cost of inspection differ with the various vendors?

How long does it ordinarily take to secure this material?

What is our delivery experience with the customary vendors on this material?

What delivery promises do they make?

If the material is required in a hurry, what vendor in view of past experience is best able to rush the material and how fast can he do it?

In your check with the requisitioner, does the time differential overbalance the cost differential?

Does the delivery date specified allow sufficient time for quotations?

If not, how important is the delivery date?

Is time required to make delivery rather uniform or is it subject to wide variations, due to manufacturing or shipping hazards?

Is usual time required to make delivery beyond our ability to predict nearby requirements, thereby warranting advance contract?

Is time of delivery requirement so short as to warrant special handling?

If requested delivery date is impossible, advise with requisitioning department so that schedules may be rearranged.

If necessary, telephone or wire the order if the ordinary routine would not be fast enough to enable the vendor to make the delivery when wanted.

Arrange with stores department to pick up material from vendors lacking delivery facilities or if material is wanted in a hurry.

On deliveries for items in controlled price markets, which is the closest reliable vendor to the job?

Is the vendor a habitual overshipper and should he be warned about this?

Should the vendor be cautioned about part-shipment orders when we have time enough to wait for a complete single shipment?

Should a cancellation clause in case of faulty delivery be inserted in the order?

Will the vendor have to check his measurements in the field?

Is the item one, the nature of which would indicate that we consider only financially large sources, or is the small producer economically in a better position to serve?

Should insurance be provided on large shipment?

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action and judgment become mechanical, it is no longer purchasing!

The items in our list are not answers. They are merely decisions which have to be made. Upon these decisions rest certain others of direct consequence, with the result that the buyer must weave a fairly complicated path, depending upon the various factors involved in the requisitioning department, the material, and the situation among the vendors at the time the material will be required.

PURCHASING DEPARTMENT

If necessary, arrange with invoice checking to withhold payments until inspection release is obtained.

Arrange follow-up for acknowledgment copy, if order is important enough to warrant need.

Obtain quotations, making sure that vendors asked to quote can furnish satisfactory material and can meet delivery requirements.

If material is unsatisfactory for any reason, negotiate with vendor for its return, either for replacement or credit as the circumstances may warrant. See that a goods returned form is sent through properly filled out in order that the vendor may be billed for the returned material.

If material is being delivered to one of our Detroit warehouses for outside stations, be sure that local warehouse can handle.

If purchase covers labor, notify vendor to have his workmen report to our superintendent before starting and after completion of job.

How extensive should the follow-up and tracing of the order be?

COST

How much did the item cost before and from whom was it purchased?

Reference to previous purchasers of the same material can be had through facilities of purchase record division.

Should quotations be submitted to the requisitioning department for approval of quality or quantities quoted on before acceptance?

What is the dollar volume of purchases on the item and how often are purchases made?

If a lump sum is quoted, what is the unit price?

How does it compare with the last unit price?

Is the size or type of package economical?

Would there be a better price if the quantity of the item was increased and how much would this increase have to be?

Can the material be incorporated with other ordered material in order to secure a price advantage on the item or on freight?

Consult user if quantity should be changed.

How long would this mean stocking the material?

Can the item be combined with materials from other departments, or added to existing orders to cut down quantity and freight differentials (especially on steel)?

Are we ordering more of the material than necessary to secure the desired price differential, and should this quantity be cut down in order to save carrying charges?

If the item is repeatedly bought, does the status of the market indicate need of a contract, price protection, or an option to contract, in order to keep from being caught by rising prices?

Is there any possibility of a freight increase, government or state tax, tariff increase, etc., on the item purchased?

What are the prospects of a freight decrease, removal of government or state tax, or tariff decreases?

Even if the same item is purchased from the same vendor, judging from your knowledge of commodity and labor markets and the make-up of the item itself, should the price be lower or higher, and how much?

Does the importance of the material justify inspection costs?

If a vendor's product would result in a saving and there is insufficient time to check before ordering, or if the requisitioning division is unwilling to accept the material without further information, what test can be started to determine whether this material can be used on future orders?

How long would the requisitioning department have to wait to get a lower price?

How much expense in long distance calls, wires, etc., is justified in ordering the material or in seeing that it gets in?

Is the market free or moderately well regulated or absolutely controlled?

If a free market, what factors tend to exert the greatest influence on price? Are statistical data regarding these factors available and are their tabulation for regular use warranted?

Does the apparent profit margin warrant *special* studies to determine availability of substitute materials?

Do the company's purchases justify a special study?

Does the probability of price decline warrant our buying piecemeal against a large job, or the negotiation of coverage against a decline?

What are terms of payment?

Is there any reason for consideration of special terms such as "10 days after receipt and inspection" or "final 10% 30 days after installation and satisfactory operation?"

Is it to our advantage to buy the item F.O.B. destination, Detroit, shipping point (is cartage required at the shipping point) or freight allowed?

If differential rate exists on F.O.B. Detroit, can arrangements be made to have vendor ship collect with freight allowed at standard rate?

If possible, have freight prepaid on material purchased F.O.B. destination.

Can destination be changed in order to obtain lower over-all handling charges such as shipping directly to destination?

Are container charges being made and on what basis (rental, direct charge, or returnable)?

If equipment is rented, can payments apply to eventual purchase?

Do you know of any vendor that has a surplus or "distressed" stock of the item you are buying?

Is some vendor possibly able to make the item as a byproduct, or as a side line to some other operation?

Does the specification involve special manufacturing methods which would tend to restrict competition or increase cost unnecessarily?

Are we getting our dollar's worth, or in other words, are we buying a product of standard quality at price favorable with such quality?

Has requisition been checked by price file?

Is it desirable to make a price analysis —i.e., a breakdown of price showing cost of materials, cost of labor, overhead, development, and profit?

FINAL

How do the vendors considered compare in financial standing and reputation? (This check is especially necessary on blanket orders and on material hard to inspect.)

If importance of order warrants, or if the company has patent rights in the subject matter, write memo for file covering any conversations not specifically confirmed either by letter or on order.

In case of a confirming order, to whom confirmed?

Should you request a copy of the order for a blanket book, savings report, or for someone that does not get the order in the usual routine?

Should extra be issued on previous order as in purchase of a boiler or similar equipment?

Notify filing clerk regarding any special filing instructions which may be required (X index references, etc.).

If cost of material is over $1,000 for a property account charge, see that a special work order number is assigned.

Assign purchase order number.

Should the auditing division be notified that all or part of the payments on this order are to be subtracted from an outstanding account?

All invoices which do not agree with the purchase order in all particulars are referred to the buyer for approval. Buyer must satisfy himself that the difference is warranted before approving invoice. If necessary, consult with vendor regarding the difference. Invoices applying to orders which have not been priced are also referred to buyer and he must be sure price charged is OK before approving.

In case of an order to an agent, or several agents, should dual signatures on the check be requested?

Should a quotation sheet be made out?

In case there is no quotation sheet, what other permanent record have you left of the negotiations on this order?

Should weights be shown for traffic information?

Obtain shipping instructions from traffic division.

Show point of origin.

Telephone orders for stock shipments so that work may be started on delivery and information looked up while placing orders with other vendors.

If sent through at "advise price and delivery," mark estimated cost on margin of departmental copy of order.

Forward executed copies of contracts to general files.

On large technical orders, send requisitioner final copy of contract.

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An examination of this list—which is, we believe, fairly typical—should convince any manager that a trained staff is required if proper weight is to be given to the various points and decisions. It should convince him that something more than a routine or clerical division is required for the operation of this part of the business. The list is offered, not as a reason for centralization or specialization, but as evidence that special personnel and special training are required for proper purchasing.

Dual-Voltage Connections for Induction Motors

Two-phase series and parallel connections, eighteen to twenty-four poles

A. C. Roe

Railway Engineering Department
Westinghouse Electric & Manufacturing Company
East Pittsburgh, Pa.

TWO-PHASE, dual-voltage diagrams for 20, 22, and 24 poles will be given in this article, together with data that will enable one to retag the leads of any eight-lead, dual-voltage connection when the tags have been lost, or if it is desired to check any dual-voltage winding for correct connections.

For connecting the leads of two-phase, dual-voltage windings to the line, Table II of the first article (July, 1932, issue of *Maintenance Engineering*) should be used in conjunction with the diagrams in this article.

On the twenty-pole, two-phase range there are four possible dual-voltage connections: (1) series and two-parallel, Figure 1; (2) two-parallel and four-parallel, Figure 2; (3) five-parallel and ten-parallel, Figure 3; (4) ten-parallel and twenty-parallel, Figure 4. These diagrams can also be used as single-voltage connections by using the rules given in the article in the February, 1933, issue, thus making possible six single-voltage connections.

With 22 poles, there are only two dual-voltage connections possible: (1) series and two-parallel, Figure 5; (2) eleven-parallel and twenty-two parallel, Figure 6. These two diagrams can be converted into four single-voltage connections at will.

On the 24-pole range, which is the last two-phase group in this series, six dual-voltage connections are possible: (1) series and two-parallel, Figure 7; (2) two-parallel and four-parallel, Figure 8; (3) three-parallel and six-parallel, Figure 9; (4) four-parallel and eight-parallel, Figure 10; (5) six-parallel and twelve-parallel, Figure 11; (6) twelve-parallel and twenty-four-parallel, Figure 12. Or, eight single-voltage connections can be made up if desired.

There are two main reasons for the checks that are applied to dual-voltage diagrams: First, to check for correctness of the connections on a new winding. Second, to check the winding in order to re-mark the leads and determine the type of connection, as series, two-parallel, etc., when the tags have been lost from the leads, or mixed.

To check the connection of any winding that has been connected by using any two-phase, dual-voltage diagram in this series, two general methods can be employed. The first consists in using the diagram in a comparative check against the winding in order to insure that the proper number of groups has been skipped; also, to check for bottom-to-bottom and top-to-top jumper connections, lead connection or location, and so on.

The second method of checking the correct connection is to apply direct current to one phase of the winding at a time, connecting the sections together for the high-voltage connection of the dual combination. Only sufficient current should be used to give a strong and positive deflection of a compass needle.

With current flowing in one phase, a compass moved around inside the bore of the stator will indicate points of positive and negative polarity—that is, north or south poles—and if the connections are correct, the north and south poles will alternate. The second phase is tested in the same manner. The polarity of its groups should be the same as in the first phase, or there should be two groups per pole of the same polarity, the next two adjacent groups should have opposite polarity, and so on around the stator.

Another simple check on correct connections is to apply a low voltage of the proper frequency to all line leads of the winding, with the other leads connected for the high-voltage connection; then place a small steel ball in the bore of the stator against the iron. If the connections are correct, the ball will revolve evenly around the core.

When the tags that are normally applied to the eight leads of a two-phase, dual-voltage motor have been lost from all or a few leads, the problem of retagging can be divided into, and covered in, six definite steps: (1) Determining the number of poles. (2) Checking the type of connection, as series and two-parallel, two-parallel and four-parallel, and so on. (3) Dividing the eight leads into four groups or sections. (4) Locating the two sections of each phase. (5) Tagging the leads. (6) Checking the connections. When making these checks it is necessary to remove the endbell from the connection end of the motor, and use a test light circuit, or buzzer. The test leads should be fitted with terminals having needle points that will pierce the ordinary insulation used on leads or jumper cable and stub connections.

1. Number of poles can be determined either from the nameplate, or by counting the total number of groups in the winding.

2. Type of connection can be established by tracing

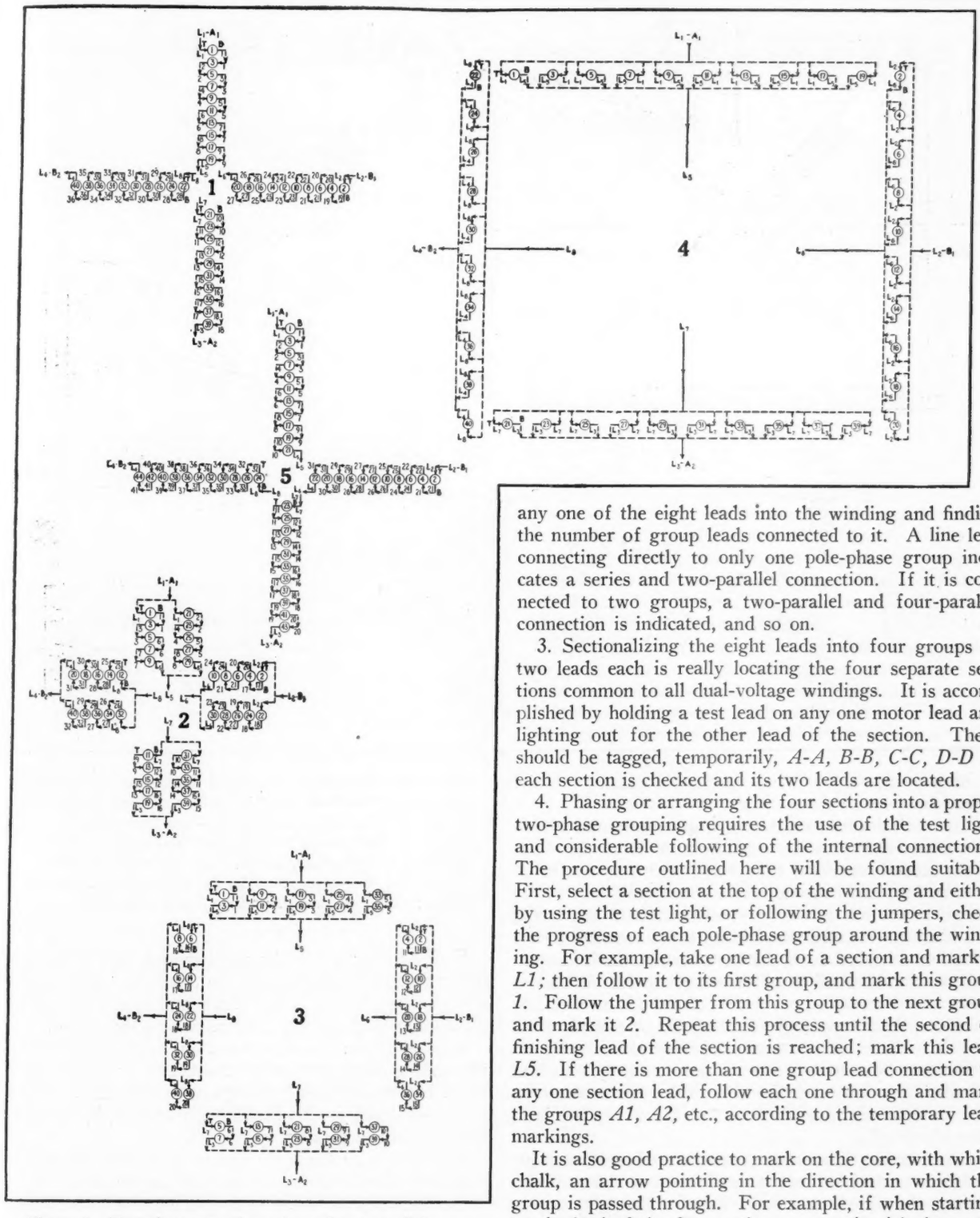

Figure 1. Two-phase, 20-pole, series and two-parallel
Figure 2. Two-phase, 20-pole, two- and four-parallel
Figure 3. Two-phase, 20-pole, five- and ten-parallel
Figure 4. Two-phase, 20-pole, ten- and twenty-parallel
Figure 5. Two-phase, 22-pole, series and two-parallel

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any one of the eight leads into the winding and finding the number of group leads connected to it. A line lead connecting directly to only one pole-phase group indicates a series and two-parallel connection. If it is connected to two groups, a two-parallel and four-parallel connection is indicated, and so on.

3. Sectionalizing the eight leads into four groups of two leads each is really locating the four separate sections common to all dual-voltage windings. It is accomplished by holding a test lead on any one motor lead and lighting out for the other lead of the section. These should be tagged, temporarily, *A-A, B-B, C-C, D-D* as each section is checked and its two leads are located.

4. Phasing or arranging the four sections into a proper two-phase grouping requires the use of the test light and considerable following of the internal connections. The procedure outlined here will be found suitable. First, select a section at the top of the winding and either by using the test light, or following the jumpers, check the progress of each pole-phase group around the winding. For example, take one lead of a section and mark it *L1;* then follow it to its first group, and mark this group *1.* Follow the jumper from this group to the next group and mark it *2.* Repeat this process until the second or finishing lead of the section is reached; mark this lead *L5.* If there is more than one group lead connection to any one section lead, follow each one through and mark the groups *A1, A2,* etc., according to the temporary lead markings.

It is also good practice to mark on the core, with white chalk, an arrow pointing in the direction in which the group is passed through. For example, if when starting on the lead of the first section a group is picked up and passed through from left to right in order to find its jumper, make the arrow point from left to right. The test light should be used to locate the other lead of each group. Thus, when tracing the first lead to a group, use the test light at the point where the first lead enters the group, and with the other terminal light out the other end of the group by pushing the needle point through the cable. By using the needle-pointed test light terminals

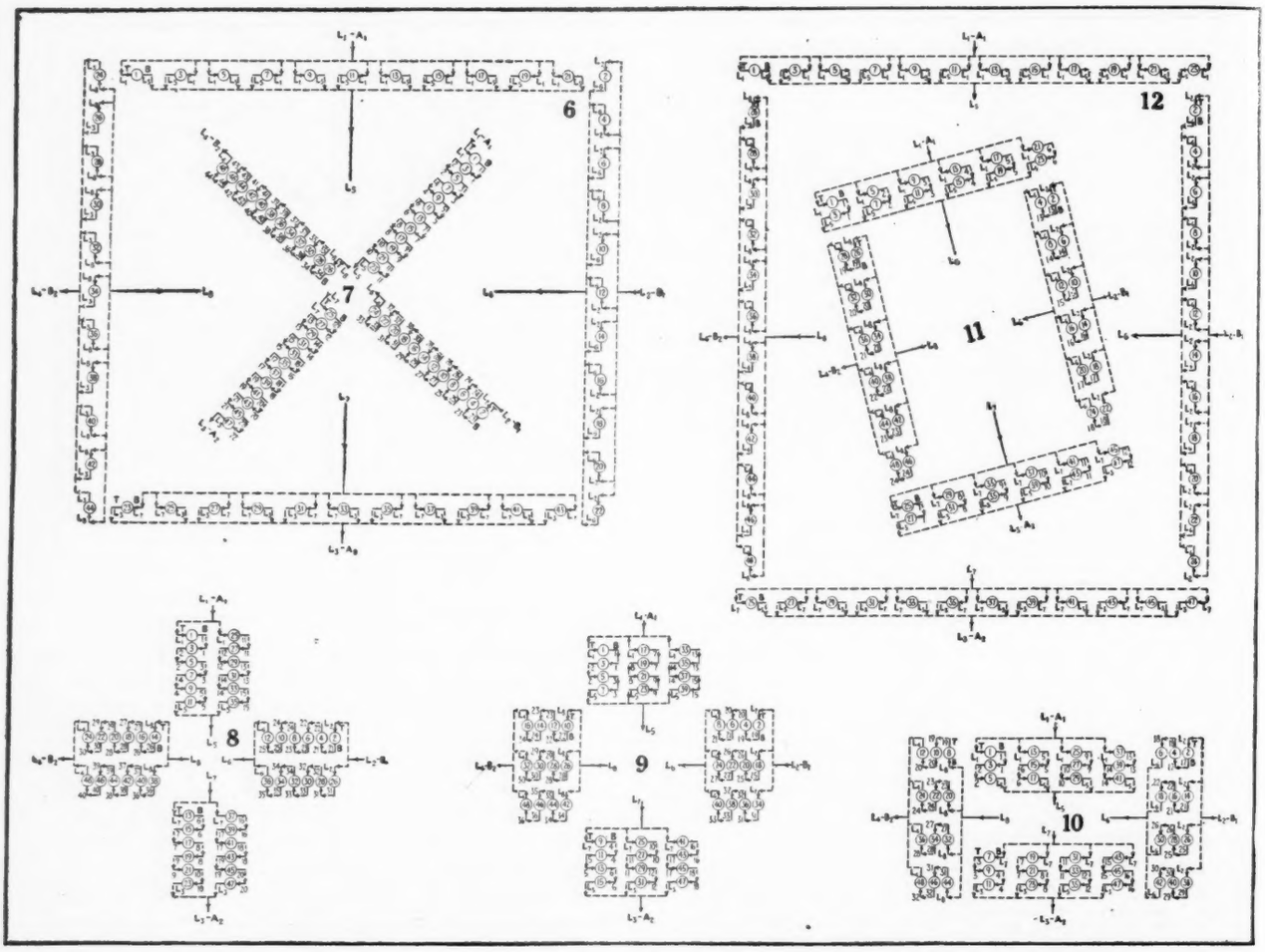


Figure 6. Two-phase, 22-pole, 11-parallel and 22-parallel
Figure 7. Two-phase, 24-pole, series and two-parallel
Figure 8. Two-phase, 24-pole, two- and four-parallel
Figure 9. Two-phase, 24-pole, three- and six-parallel
Figure 10. Two-phase, 24-pole, four- and eight-parallel
Figure 11. Two-phase, 24-pole, six- and twelve-parallel
Figure 12. Two-phase, 24-pole, 12- and 24-parallel

at each group, there is no danger of picking up the wrong jumpers or groups.

After locating and marking the groups of one section of a phase, it is possible to pick out definitely the leads of the second section of this phase, since the number of poles and type of connection are known, and half of the groups in the one phase have been marked. Referring to a diagram, for example, Figure 1, assume that groups *1* to *19* and leads *L1* and *L5* have been marked. Figure 1 shows that lead *L7* should be on group *21*. We know also that the arrow on group *19* pointed out on lead *L5;* therefore, the arrow on group *21* should point away from lead *L7*. Count over to group *21* and make sure by use of the test light that the arrow points away from lead *L7* and in the opposite direction to the arrow on group *19*. In this way leads *L7* and *L3* in the A phase have been identified.

A connecting diagram can now be used and the group numbers marked on the groups located in the A phase, leaving the arrow markings intact. By referring to Figure 1 it will be found that the B phase and lead *L2* should start on group *2* and the direction of the arrow should be the same as on group *1*. Then check group *2* on the winding, and by use of the test light locate the internal lead connecting to this group. If the arrow direction is correct, this lead can be marked *L2,* and the remaining lead of the section marked *L6*. This section should be traced through also and the groups numbered and marked with arrows to *20,* the final group.

Figure 1 shows that the starting lead, *L8,* of the section is attached to group *22;* the test light makes it possible to locate this group lead and check its arrow direction with group *20*. The remaining lead is *L4*.

As soon as the type of connection is established, a corresponding diagram should be obtained or drawn up to assist in checking and lighting out the winding. It will help considerably with parallel connections, by preventing mistakes in picking up groups.

5. Tagging of the leads can now be attended to. A metal tag should be applied to each motor lead.

6. Checking the winding is greatly simplified by the chalk-marked arrows and the numbers applied while tracing out the leads. Or, the compass test can be used, and the simple steel ball test will indicate whether it is safe to reassemble the motor and try it out on the line.

From the preceding discussion it will be evident that retagging a dual-voltage winding is practically a matter of reconnecting, and that the rules for connecting diagrams must be followed, or a sketch of the connections used, in order to accomplish the retagging operation.

QUESTIONS and ANSWERS

Conducted by G. A. VAN BRUNT

Divided Responsibility Leads to Arguments

Repairs and upkeep of production machines are handled by the machine shop, which is a division of the production department. Lubrication and adjustment of machines, and servicing of all other equipment are in charge of the maintenance department. When machines develop trouble there is frequently much "buck-passing." Sometimes it is impossible to fix responsibility for breakdowns because two departments are involved. Doubtless other readers have faced this problem, and I wish they would tell me how they solved it. J.M.B.—*Cleveland, Ohio*

THERE are two solutions to this problem, both of which I have seen applied successfully.

The first one is to set aside a portion of the machine shop for the exclusive use of the maintenance department, or transfer the necessary machine tools for maintenance work and employ only maintenance men who are competent machinists.

Then assign one man to the job of servicing one or a group of machines, making him directly responsible for the machinery under his care insofar as lubricating, adjusting, and the replacing of all worn parts, which includes machining, are concerned. This arrangement

ANSWERS WANTED

How Could This Machine Become Charged?

When the operator of a portable loading machine pressed the starting button presumably he received a shock that knocked him down, his hand remaining in contact with the machine frame. Another operator seized his foot in order to pull him away, and also received a shock. About two minutes elapsed before the machine was disconnected. Artificial respiration and stimulants failed to revive the operator, and he was pronounced dead after an hour.

The loader is driven by a 10-hp., three-phase, 60-cycle, 440-volt motor. The feeder is a No. 8, three-conductor, rubber-covered cable running to a metal-inclosed safety switch on the machine. A push-button control station is also located on the same side. Three-conductor BXL cable runs from the switch and button to the conductor and then to the motor.

There are two rear driving wheels on the machine, 4 ft. in diameter, 1 ft. wide; these wheels were embedded about 4 in. in clay, sand, and water. One could assume that it was well grounded, since inclosures for all-current-carrying parts and the entire framework was riveted and bolted together, with bronze wheel bushings on the axles.

Operating voltage is 480 volts between phases, supplied by a bank of 2,300/440-volt transformers connected delta-delta, ungrounded. One leg of the system was found to be grounded on another branch circuit. Testing from each of the two ungrounded legs showed 480 volts between the line and machine frame. An ammeter in series with these lines and the machine read 28 amp. in each case, which seems to show that the machine was well grounded. A Megger test of the wiring with the contactor closed showed a reading to ground of 50,000 ohms. With the motor disconnected two of the lines showed 50,000 and the other 70,000 ohms.

When the machine was started at the request of the coroner no shock could be obtained in any manner by touching the frame, push-button or switch box.

All tests have failed to show how it was possible for the operator to receive sufficient current from the framework of this machine to cause death, but the evidence, which includes burns on the hands and other parts of the body, as well as the results of an autopsy, shows that he did.

Many will say that if this machine had been permanently grounded such an accident could not have happened. The question still remains as to why a sufficient amount of current to cause death could pass through the operator's body when more than 5 sq.ft. of the machine was embedded in the earth and water, whereas there was only a small contact area between his body and the damp ground on which he was standing.

Thousands of similar machines are in operation. If any reader can tell how this accident happened he may prevent a similar occurrence elsewhere. X.Y.Z.

Determining Unit Plating Costs

We have had difficulty in setting up a simple, practical system for finding the cost of electroplating our products. The parts are of various sizes and shapes, and are plated with copper, nickel, brass, cadmium, or chromium in barrels which are immersed in the plating solutions. Lots may vary from a few hundred to several thousand. Three men are employed in the plating department, but the labor chargeable to jobs is small. The three men can clean a batch of parts, place in barrels, immerse in the plating bath, and remove after plating, in from ten to fifteen minutes per barrel. The plating process requires from one to three hours, during which the men make chemical solutions, clean tanks, and do other work that is not directly chargeable to any one job. How can we best arrive at unit material, labor, and burden costs?

J.H.R.—*Lancaster, Pa.*

leaves the machine shop free for production work alone and places responsibility where it should be placed—on each individual member of the maintenance department.

The second solution is to assign to each maintenance man one or a group of machines which he is to lubricate, adjust, take down in case of overhauling, repair, and assemble. The machine shop should be held responsible for the machining of repair parts to maintenance department specifications, its responsibility ending when the part leaves the machine shop after being inspected and approved by the maintenance man who submitted the repair. Should the part fail to prove unsuitable in any way, he alone is held responsible.

Both procedures aim at segregating the different functions and responsibilities of the machine shop and the maintenance department, and in this respect they have been entirely successful.

ROBERT S. ALEXANDER, *Providence, R. I.*

Motors and Controls for Centrifugal Pumps

We plan to install two centrifugal pumps, one to be driven by a 5-hp., and the other by a 10-hp., 220-volt, 60-cycle motor. Current will be supplied by a 20-kva. m.g. set. The motors will be controlled automatically by float switches. Although the starting loads will be light, the lowest possible starting surge is desirable because of the low capacity of the current supply. Will someone tell me the best type of motor and starting equipment for this job? Would a slipring motor with a three-point automatic starter be satisfactory? Please compare this with other types of starters that might be used here and give the advantages and disadvantages of each. *A.E.A.—Lake Placid, Fla.*

SINCE the speed of the motors is not given, these comments are based on a normal 1,800-r.p.m. squirrel-cage induction motor. The 5-hp. motor would require approximately 6½ times normal full-load current if started on full voltage. It could be started with a resistance-type starter and the current limited to 4½ times normal; with an auto-transformer type starter, the current will be limited to approximately 2¾ times normal. Either of the reduced-voltage methods of starting will provide approximately 80 per cent torque which should be ample for starting the pump.

If a wound-rotor motor with a two-point starter is used, the current inrush will be approximately twice normal on the first point, falling off as the motor comes up to speed and again reaching twice normal when full voltage is applied to the motor. If a three-point starter is used, there will be three equal peaks of approximately 150 per cent normal. Obviously the wound-rotor motor with the three-point starter will impose the lowest peak load on the generator, but the equipment will be much more expensive than the two-point starter. It is my opinion that unless it is necessary to limit the current inrush, either a wound-rotor motor with the two-point starter or a squirrel-cage motor with an auto-transformer type of starter should be used.

A 10-hp. motor of the normal-torque, low-starting-current type would require approximately five times normal current if thrown across the line. Started with a resistance-type starter it would require 3.2 times normal full-load current, and if started with the auto-transformer type starter would require approximately 2.2 times normal full-load current. The low-starting-current type of motor normally is not used with reduced-voltage starters since it is slightly more expensive but in this case the increased expense would probably be justified. The normal type of squirrel-cage motor would require approximately 7 times normal current if started on full voltage, or 4½ times normal current if started with a resistor-type starter. If started with an auto-transformer type starter it would require approximately 3 times normal current. By using the low-starting-current type of motor with an auto-transformer starter the current is reduced from 3 times normal to 2.2 times normal.

If the wound-rotor type of motor with a two-step starter is used, the current peaks will be approximately twice normal, whereas if the three-step type of starter is used, there will be three peaks, each 1½ times normal.

Summarizing, I recommend that an auto-transformer starter be used with the 5-hp. motor unless the reduction from 2¾ times normal to twice normal current is worth a considerable increase in expense. For the 10-hp. outfit I recommend a normal-torque, low-starting-current motor with an auto-transformer starter. To reduce the current peaks much more it would be necessary to use a wound-rotor motor with a three-step starter, which would cost more than twice as much.

A. E. BEARDMORE, *Industrial Engineering Department General Electric Company, Schenectady, N. Y.*

THROWING the 5-hp. motor across the line and using a resistance or auto-transformer starter with the 10-hp. motor may be the answer to this question. Provided the motors are arranged so that they do not start at the same time the starting surge, with the above set-up, would always remain within the capacity of the m.g. set. The assumption is, of course, that the m.g. set can stand 150 to 175 per cent momentary overload, which is usually the case.

If it is necessary to keep the starting surge down to an absolute minimum, undoubtedly the best way to do this is to use slip-ring motors with automatic starters which, if properly adjusted, will keep the starting surge within the full-load requirements of the motors.

Both motors might be used in connection with automatic resistance-type starters or auto-compensators. However, the surge when starting a 10-hp. motor by one of these two methods will be about the same as when starting the 5-hp. unit across the line.

Comparing the use of automatic resistance starters against compensators with squirrel-cage motors, the compensators are somewhat higher priced. With a resistance-type starter (the resistance is cut in series with the motor) the current in the line is the same as the current in the motor; the advantage of a compensator is that these currents are not the same. A desirable feature about a resistance-type starter, however, is that it gives a smooth starting cycle.

Comparison of the initial costs of the various suitable combinations indicates that the least expensive will be a 5-hp. squirrel-cage motor with across-the-line starter and

(*Continued on advertising page 36*)

·EQUIPMENT NEWS·

Meters

Worthington Pump and Machinery Corp. and Gamon Meter Co. have consolidated their operations in the manufacture and sale of meters, through the Worthington-Gamon Meter Co. Sales headquarters at Harrison, N. J. Manufacturing at Gamon plant in Newark, N. J. Complete lines of meters built by both companies will be continued.

Goggles

With cups of transparent material which enable wearer to perceive objects through them. Light passes through walls of cup undimmed and permits normal eye condition. Goggle has strength to withstand impact, is spark proof and light in weight. Can be worn over spectacles. Willson Products, Inc., Reading, Pa.

Pulleys

"Wedgbelt" line now includes pressed-steel pulleys in the larger diameters. Added sizes utilize "American" hub and arm construction, mounting the steel grooves upon the pulley face. American Pulley Co., 1400 S. Penn Sq., Philadelphia, Pa.

Hose

Fire. Wax and gum single jacket. "Hydroseal" treated. Treatment contains fungicide. Also "Hydroseal" treated inner jacket of double-jacket hose. "Bock" brand brewers' hose has been restored to line; sizes ¾, 1, 1¼, and 1½ in., four ply, and 1½ and 2 in. five ply. The B. F. Goodrich Rubber Co., Akron, O.

Floodlight

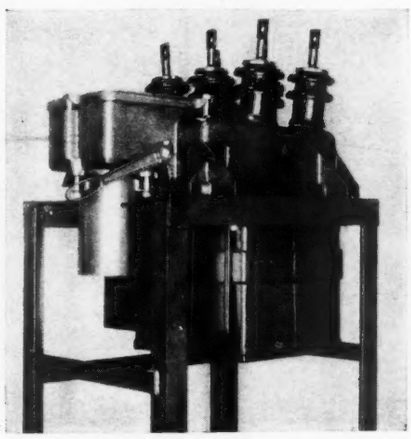
"Exposition Model 1,000-watt Handy Floodlight." Projector casing of spun aluminum with dark green baked-enamel finish. Reflecting surface is interior of casing, etched finish. Convex, heat-resisting glass lenses, 15½ in. diameter. Either 500-watt or 1,000-watt incandescent lamps. Mountings are swivel and stand type. General Electric Co., Schenectady, N. Y.

Alloy

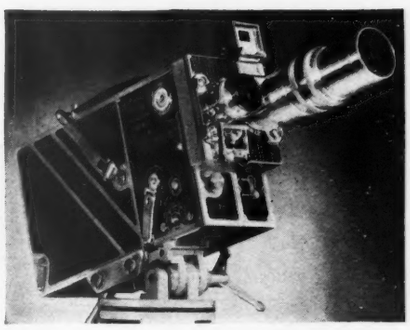
"Durichlor," said to be almost entirely resistant to hydrochloric acid at all concentrations, all temperatures up to boiling point. Used for chemical-handling equipment. The Duriron Co., Inc., Dayton, Ohio.

Breaker

Automatic, reclosing, Type Fo-22, for lightly loaded or rural feeders. Self-contained, 7,500 volts, with 50,000 kva. interrupting capacity rating on the 2—OCO cycle. Automatic reclosing equipment is mounted within the breaker mechanism housing. Operates over a CO one second OCO 2.8 seconds OCO lockout duty cycle. Breaker is solenoid operated, from an a.-c. source



by means of a "Rectox," mounted in a distribution transformer tank. Westinghouse Electrical & Mfg. Co., East Pittsburgh, Pa.



Motion Picture Camera

"Ciné-Kodak Special," 16-millimeter, designed to fit the needs of engineers, manufacturers, laboratory technicians. Incorporates provisions for double or multiple exposure, dissolves, slow motion, fades, masking, interchangeable film chambers, variable speed, framing. Has variable shutter, two-lens turret, provision for hand, spring, or motor drive. A 1-in., f. 1.9, Kodak anastigmat lens is standard. Available lenses include: 15-millimeter f. 2.7 wide-angle, 2-in. f. 3.5, 3-in., 4½-in. and 6-in. telephoto. Eastman Kodak Co., Rochester, N. Y

Geared Motor Reducer

For mechanical reduction from normally high motor speed to satisfactory operating speeds. "Type S" reducers are simple, compact units, designed for drives from ½ to 75 hp. and for a range of speeds from 1,550 to 232 r.p.m. in 14 steps for each motor speed and horsepower. May be connected direct to the driven equipment or by cog-belts, chains or flat belts. Helical gears, fully enclosed and running in a continuous oil bath, insure quiet operation. Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.

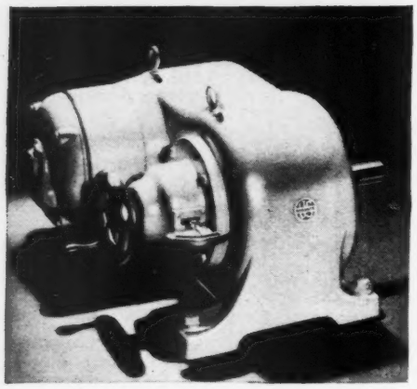
Hoist

"Hercules," high-speed, with patented safety overload governor. All features of ordinary spur-geared hoists. Rugged, simplified construction—designed for heavy-duty service. Patented governor warns against dangerous overloads. Hoist also incorporates adjustable load brake, which prevents self-lowering of load. "Quick Lowering" (optional) in smaller capacities speeds up handling in production line. Available in range of capacities, from 14 tons to 40 tons;

equipped with electric-welded "Inswell" load chain. Chisholm-Moore Hoist Corp., Tonawanda, N. Y.

Motor

"Varidrive" offers infinite number of speeds within the range instantly controllable while driven machine is in motion. Variation of speed is accomplished



by microspeed control. Motor speed is constant. An electro-mechanical power conversion device is used. U. S. Electrical Mfg. Co., Los Angeles, Calif.

Geared Motor Reducer

"Syncrogear," self-contained, single-base, geared transmission, inclosed. Anti-friction bearings. Ratings: motor speeds, 3,600 r.p.m. or lower; geared reduced speeds, down to 2 r.p.m.; geared over-speeds, up to 10,000 r.p.m.; geared speed conversions from 50 to 60 cycles. U. S. Electrical Mfg. Co., Los Angeles, Calif.

Splash Proof Motors

One to 30 hp. Primarily intended for typical splash-proof installation, but recommended by the maker for outdoor installations where protective buildings or covers are not available. One-way ventilation. Bearing bracket fitted to frame by long contact sealed fit. Cartridge-type grease-lubricated ball bearings. Century Electric Co., St. Louis, Mo.

Air Conditioning Equipment

Self-contained room coolers for summer, portable, floor and wall types; room coolers operating from remote compressors; complete unit for year-around conditioning; and a central system which will be installed to fit the requirements of individual premises. General Electric Co., Schenectady, N. Y.

Chain Device

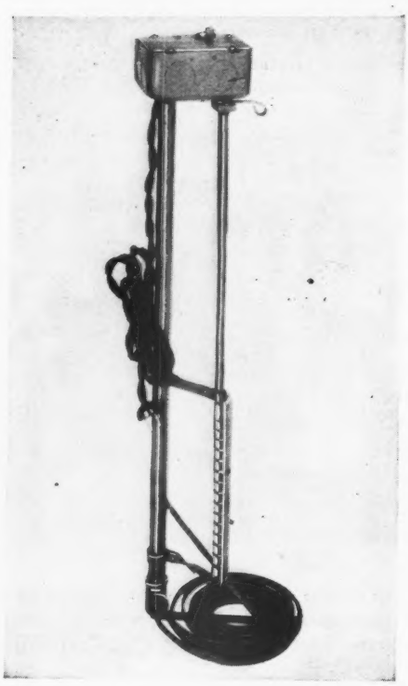
For preventing vibration and whip in roller and silent chain drives. Consists of small, wedge-like elements assembled into standard chains at every pitch. Wedges contact end to end and form continuous backbone. The elements float on the chain rivets, are said not to interfere with normal chain action, and are provided to serve as check links to prevent back bend and chain whip with pulsating loads. Chains in which check links are assembled run on standard sprockets. Whitney Mfg. Co., Hartford, Conn.

Valve

Rubber-lined, for handling corrosive and abrasive fluids under conditions of fairly high pressure, pulsating pressure, throttling or suction. "Vulcalock" may be lined with any standard "Goodrich Acidseal" rubber compound, hard or soft, depending upon conditions of service. Action depends on a resilient, rounded disc which snaps over a circular plate at lower end of stem, providing absolute seal in contact with molded rubber-covered seat. Rubber lining bonded to metal parts by patented process. B. F. Goodrich Rubber Co., Akron, Ohio.

Immersion Heater

For heating water, oil, or other liquids. Thermostat control, 80 to 180 deg. F., maintains one degree plus or minus. Capacity 1,200 watts 110 volts a.c., 1,650 watts 110 volts a.c., 5,000 watts or less, 220 volts a.c. Thermador Electrical Mfg. Co., 116 Llewellyn St., Los Angeles, Calif.

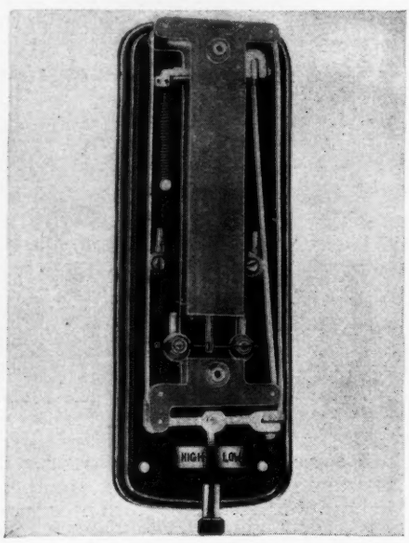


Pipe Cutters

For brass and copper tubing and pipe. No. 00 for tubing or pipe up to $\frac{3}{4}$ in. outside diam., is a three-in-one tool carrying reamer at one end and flaring tool as an integral part of the handle. Tool measures 6 in. from handle to tip and is cadmium-plated. No. 0, for larger, regular and hard copper tubing, also brass and copper pipe up to $1\frac{1}{2}$ in. outside diam., is without reamer or flaring tool. "Trimo" cutters are of Saunders design with two rolls and one wheel. Said to produce a square cut and leave no rough edges to be filed down. Trimont Mfg. Co., Inc., Roxbury, Mass.

Humidity Control

"Humitrol." Open contact. For use with transformer in low-voltage air-condition-control systems up to 25 volts. Direct application to equipment drawing



25 watts or less; application with transformer-relay combination for equipment drawing more than 25 watts. Can be set to control humidity at any desired per cent up to 100. Lewis Air Conditioners, Inc., 829 Second Ave., South, Minneapolis, Minn.

Photoelectric Relay

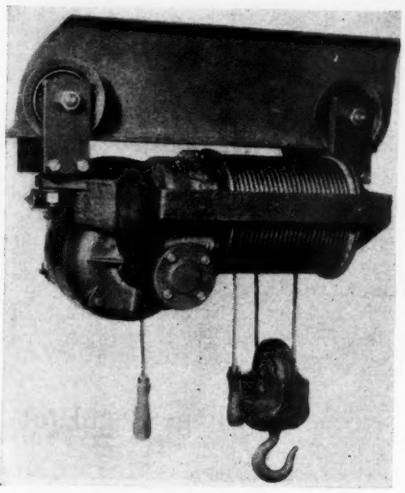
"Improved General Purpose." Type CR7505-A4. Successor to type CR7505-A3. Single-pole, double-throw, snap switch eliminates necessity of wiring changes for operation on admitted or excluded light. Utilizes Pliotron tube. General Electric Co., Schenectady.

Hose Couplings

"Meyer" $\frac{3}{8}$-in. air-hose couplings. Free-swiveling, threadless. Push connect, pull disconnect. Spear-Tap Mfg. Co., Inc., 433 South Spring St., Los Angeles, Calif.

Hoist

"ElectroLift." For suspension from I-beam trolley or from trolley of any monorail or tramrail system. Worm



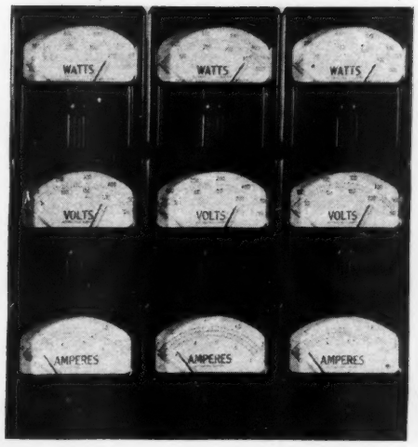
driven, with hoisting unit inclosed in oil-tight case. Gears and bearings operate in grease. Motor brake stops hoist when current is off. Rope-type or push-button control. ElectroLift, Inc., 30 Church St., New York, N. Y.

Acid Indicator

Determines acid content of solutions and mixtures used in food, beverage, pharmaceutical, fermentation and silver processes. Termed "Electrynx," it is a sensitive micro-ammeter which measures the small e.m.f. across two dissimilar metals when they are inserted in materials having acid or alkaline reaction or a trace of salt. Complete outfit consists of the indicating instrument with mounting clamp, a set of six pointed electrodes, and accessories for mounting to any testing fixture. Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.

Switchboard Instruments

Type "K," illuminated, flush mounted. Occupy panel area 4 in. wide, $4\frac{1}{4}$ in. high. Mountable in close grouping. Scale length $3\frac{1}{2}$ in. Types available to indicate volts, amperes, watts, power factor, frequency, reactive volt amperes, and radio frequency amperes. Permanent



magnet moving coil mechanism available for volts, amperes. "Rectox" voltmeters, and milliammeters; also temperature indicators. Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.

Air Conditioning Equipment

Individual, self-contained units, for heating, humidifying, cleaning, ventilating, cooling, dehumidifying, and eliminating noises entering from outside. Central units for large or small buildings utilizing ducts to deliver conditioned air to desired points. The "Decalorator," for providing cold, uses steam and tap water. American Radiator & Standard Sanitary Corp., 40 West 40th St., New York, N. Y.

Packing for Valves

Laminated rings for high steam pressures and high temperatures. Consist of stainless-steel rings with asbestos between, compressed and heat-treated. For use in "Yarway Seatless Blow-off Valves." Yarnall-Waring Co., Chestnut Hill, Philadelphia, Pa.

Pneumatic Transport System

"The Mechanical Man," for conveying cement, pulverized coal, and other fine materials. Transporting apparatus may be connected to discharge opening of material bin, receive its feed from a conveyor, or take discharge direct from a pulverizer.

Consists of weighing tank automatically filled and emptied by air pressure, mounted on springs, carried on structural-steel frame held up by supports which allow conical bottom to project between them. Discharge cone has automatically operated discharge gate, between which and stationary discharge line a wear-resisting hose forms flexible connection. Flexible filling sleeve for attaching to source of feed contains automatic shut-off gate, air-operated, to allow material to flow into empty tank but cut off flow when tank is full.

Can be used as permanent installation or for loading cars, ships or trucks. Kennedy-Van Saun Mfg. & Eng. Corp., 2 Park Avenue, New York, N. Y.

Circuit Breakers

Complete line of small breakers, rated up to 600 volts, 600 amp., designated as AF-1, and designed for the control and protection of industrial circuits. General Electric Co., Schenectady, N. Y.

Mercury Switch

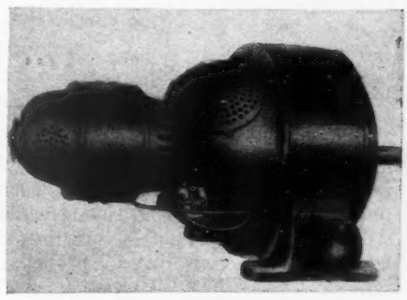
Refractory protected to confine arc and prolong life. Nominal ratings from 3 amp. to 50 amp. Single pole, single throw, for either a.c. or d.c. circuits. Flexible leads 6 to 8 in. long. Special mounting clips available. Diameter 0.410 to 1.270 in., length 2 to $4\frac{1}{8}$ in. Totally inclosed and hermetically sealed. Westinghouse Lamp Co., Bloomfield, N. J.

Air Compressors

Rotary compressors and vacuum pumps. Multi-cellular, sliding-vane type, water-cooled and air-cooled designs. Range from 50 to 2,000 cu.ft. per min. at pressures up to 150 lb., vacuums up to 29.85 in. mercury. Air-cooled units for pressures up to 10 lb. gage, and vacuums up to 18 in. mercury; water-cooled for higher pressures and vacuums. Units operate at standard motor speeds. Allis-Chalmers Mfg. Co., Milwaukee, Wis.

A. C. Generators

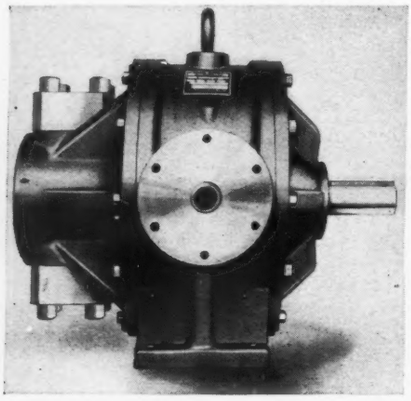
Ranging from 0.6-kva. to 75-kva. capacity. Separately excited type, have d.c. exciter bolted directly to main generator frame. Three-phase, three-wire and four-wire machines; also single-phase, two- and three-wire types in all standard sizes up to 75 kva., three phase,



and up to 50 kva., single phase. For use with any prime mover. Marble-Card Electric Co., Gladstone, Mich.

Radial Pumps

H-P-M series, positive displacement, multiple-radial plunger, oil-pressure type. For generating pressure in operating hydraulic-powered machinery.



Output is variable in volume, reversible in direction. Six sizes, from 1 gal. per min. to 100 gal. per min., with pressure capacities up to 3,000 lb. per sq.in. Hydraulic Press Manufacturing Co., Mount Gilead, O.

Drills

The drill business of Armstrong Mfg. Co. has been acquired by Bucyrus-Erie Co., South Milwaukee, Wis. Armstrong drills and bit sharpeners will be manufactured and sold by Bucyrus-Erie.

Motor

"Doublenclosed," explosion-proof. Type SD complies with underwriters' Class II Group G specifications for explosive dust conditions; type SE with underwriters' Class I Group D specifications for explosive inflammable gas conditions. Fan, mounted between two inclosing frames, removes dust, fumes, and foreign matter from air-passages between shells. U. S. Electrical Mfg. Co., Los Angeles, Calif.

Fans

Goodwill, patents and tools of Arcoil Manufacturing Co., Newark, N. J., makers of "Arcoil" squirrel-cage-type fans, have been purchased by Torrington Mfg. Co., Torrington, Conn., which will manufacture and sell this line in addition to its own line of propeller-type fans.

Motor Starter

Addition to Allen-Bradley line. Splash-proof, hand-operated, for motors up to 3 hp., 110 volts; 5 hp., 220 volts; and 7½ hp., 440-550 volts. Operating mechanism identical to standard Bulletin 609. Cadmium-plated cabinets provided with rubber cover gaskets. Splash-proof push buttons in cabinet cover actuate switch and exclude moisture from switch mechanism. Allen-Bradley Co., 1311 S. First St., Milwaukee, Wis.

Boiler Tubes

Hot-rolled, seamless steel. Comply with A.S.M.E. Boiler Code and A.S.T.M. Specifications. Jones & Laughlin Steel Corp, Pittsburgh, Pa.

Furnace Coating

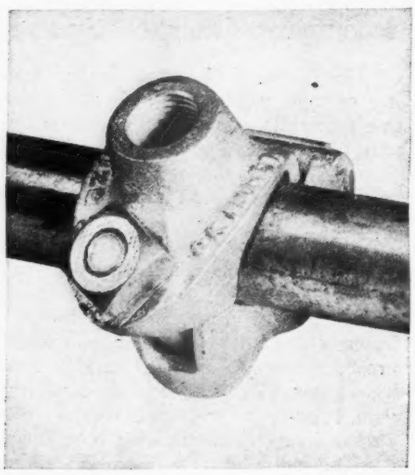
"Fire-Kote," vitrified, for refractory walls. Manufacturer announces that it contains no silicate of soda, fuses progressively between 1,200 and 2,800 deg. F., does not refuse or run at higher temperatures, will not check or flake off. Mildon Engineering Co., Inc., 25 Broadway, New York, N. Y.

Truck

Winch type, with roof that may be slid forward to expose interior for overhead loading and closed to protect contents during transit. American Coach and Body Co., 3809 Clark Ave., Cleveland, O.

Saddle Tee

For installing gas and water appliances. Combines tee, union, and nipple. No pipe cutting nor threading necessary. Made of malleable iron, cadmium plated. Sizes ½ to 8 in. Special drilling device also available. M. B. Skinner Co., Sample St. at Falcon St., South Bend, Ind.



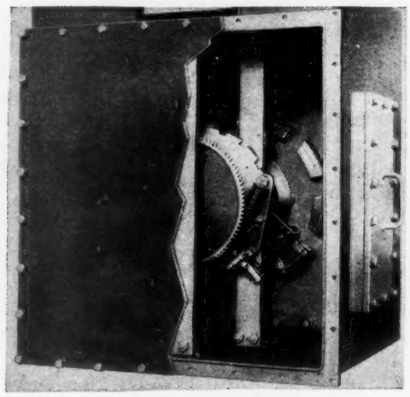
Motor-Operated Valves

For temperature and humidity control. Electrically driven. Suitable for remote automatic or manual control. Include full-balanced, piston-disk, 5- to 12-in. models for pressures up to 125 lb.; single-seat type with renewable composition disk, sizes from 2 to 6 in.; semi-balanced, double-bronze-disk type, with vee-port disk, 2 to 4 in., with standard disk, 5, 6 and 8 in. Barber-Colman Co., Rockford, Ill.

Air Brush

G-6 gun has "out-in-the-clear" fluid plunger packing chamber, variable trigger tension, regulation of flow and width of spray. Employs fan-slot "internal mix" nozzles. Extensions up to 8 ft. in length. Eclipse Air Brush Co., Inc., 77 Orange St., Newark, N. J.

Feeder Voltage Regulator



Automatic, for application where induction type has been used. Operates on basis of an automatic tap-changing device with suitable transformers. For either indoor or outdoor application, single- or three-phase operation. Allis-Chalmers Mfg. Co., Milwaukee, Wis.

Utility Blow Torch

"750 Everhot Utility Tool," portable, continuous-heated. Detachable tips include soldering irons, flame reducer, flame spreader, ladle, dipping cup. Flame plays continuously on iron or cup. Intensity can be regulated. Everhot Mfg. Co., Dept. B-8, Maywood, Ill.

(For Trade Literature see page 31)